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Ord et al.

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(54) PRINTER INK SUPPLY SYSTEM

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B41J 2/175 (2006.01)

(52) **U.S. Cl.** **347/85**

(58) **Field of Classification Search** 347/7, 347/19, 85, 86; 271/114
See application file for complete search history.

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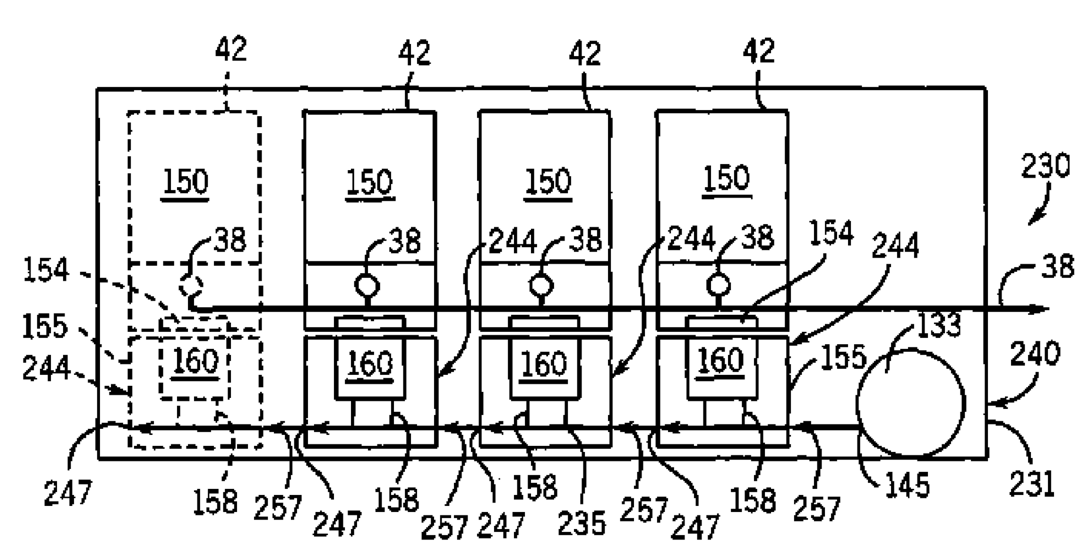
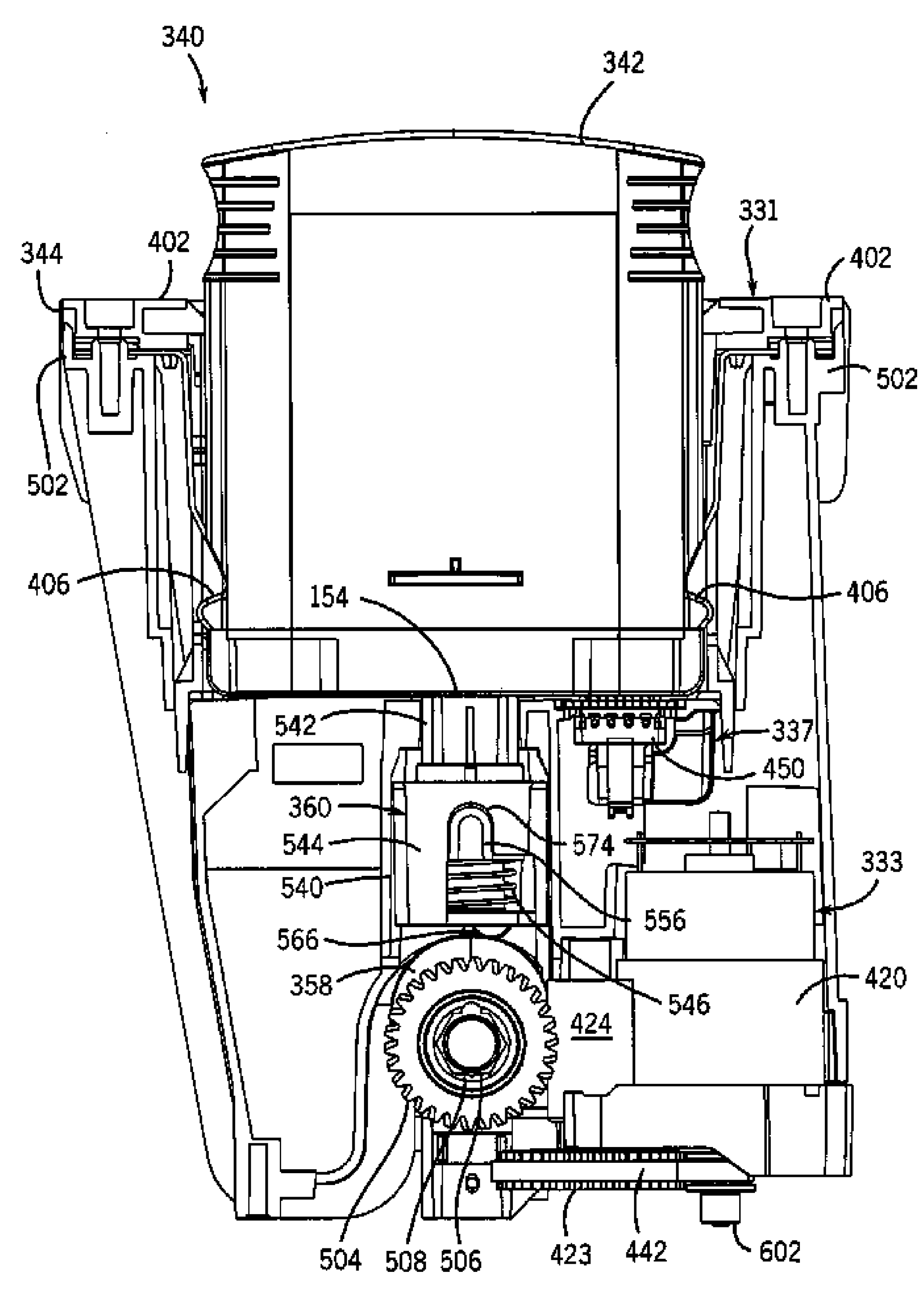
(57) **ABSTRACT**

An ink supply station for use with a first ink supply and a second ink supply includes a first module and a second module releasably coupled to the first module. The first module includes a first chassis and a first movable member supported by the chassis, wherein movement of the member causes flow of ink from the first ink supply. The second module includes a second chassis and a second movable member supported by the second chassis. Movement of the second member causes flow of ink from the second ink supply.

67 Claims, 10 Drawing Sheets





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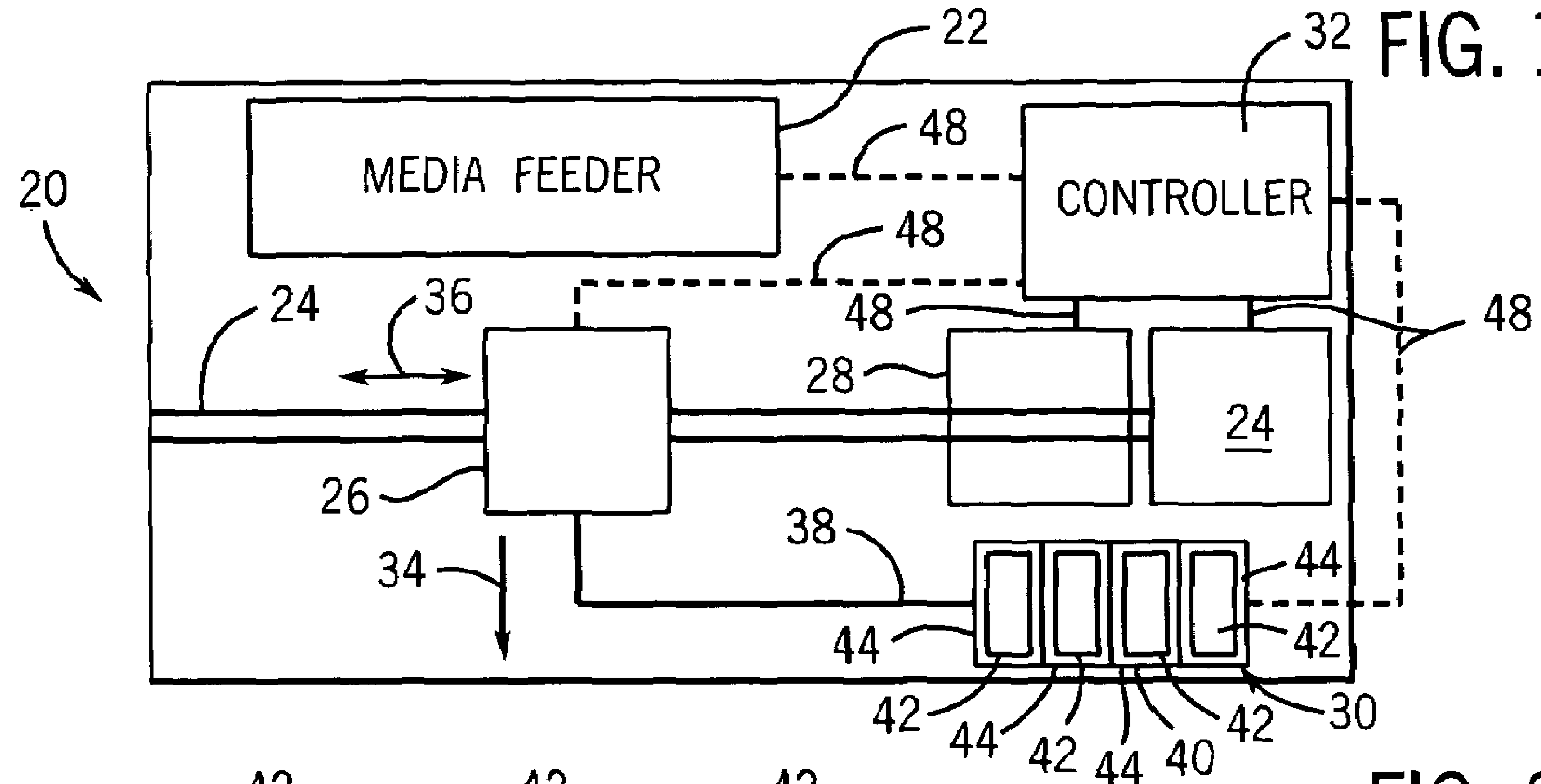

FIG. 1

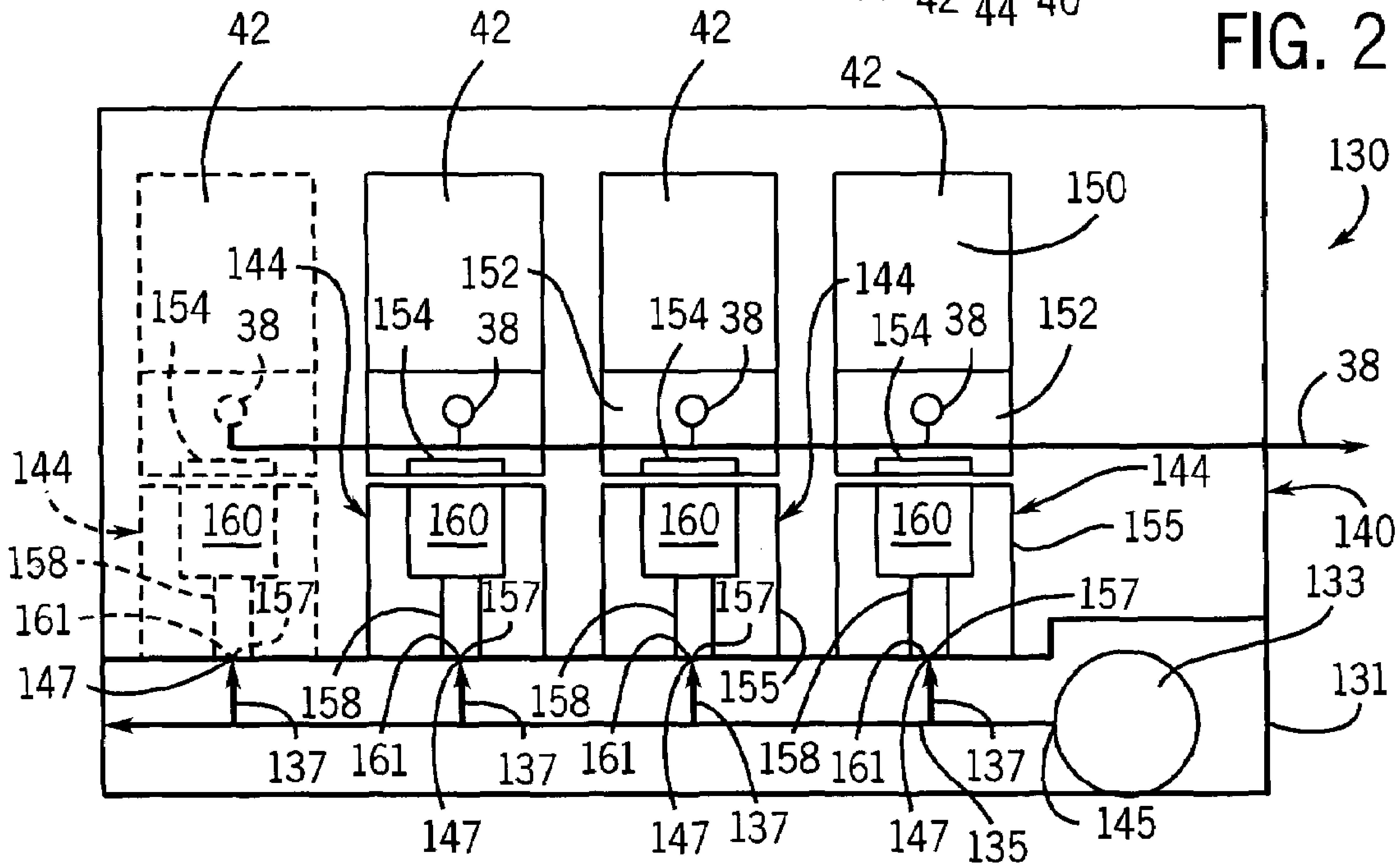

FIG. 2

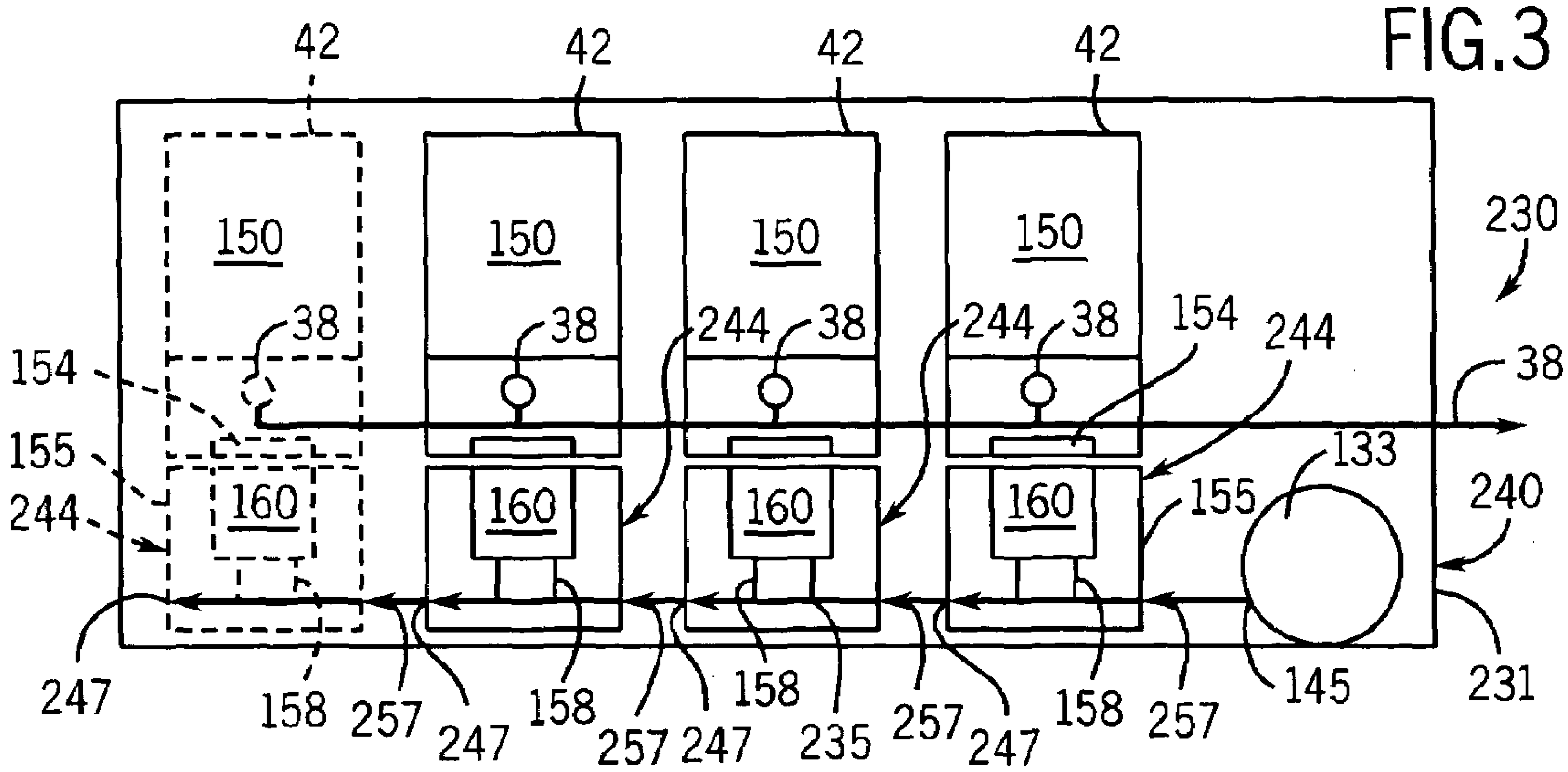

FIG.3

FIG. 4

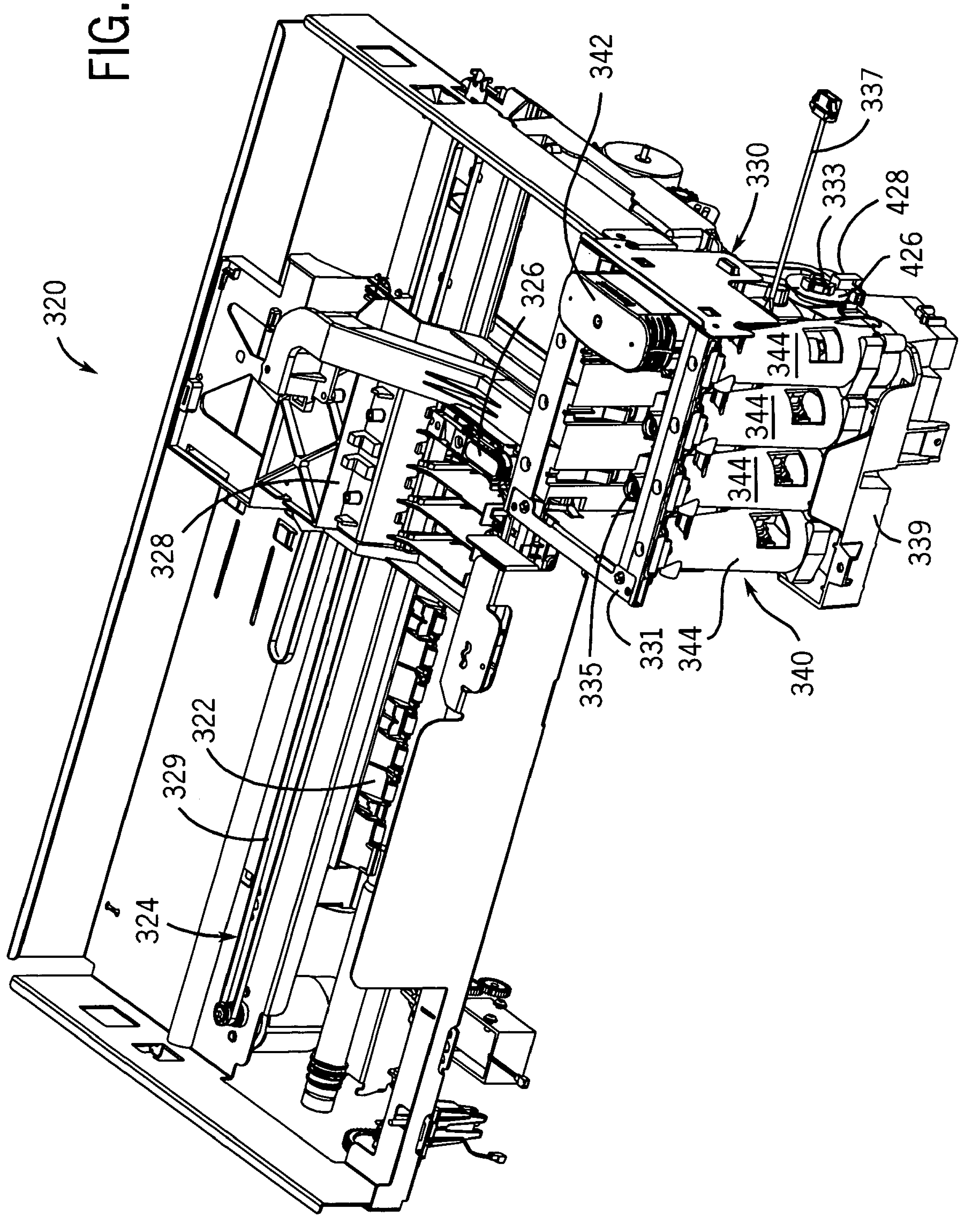
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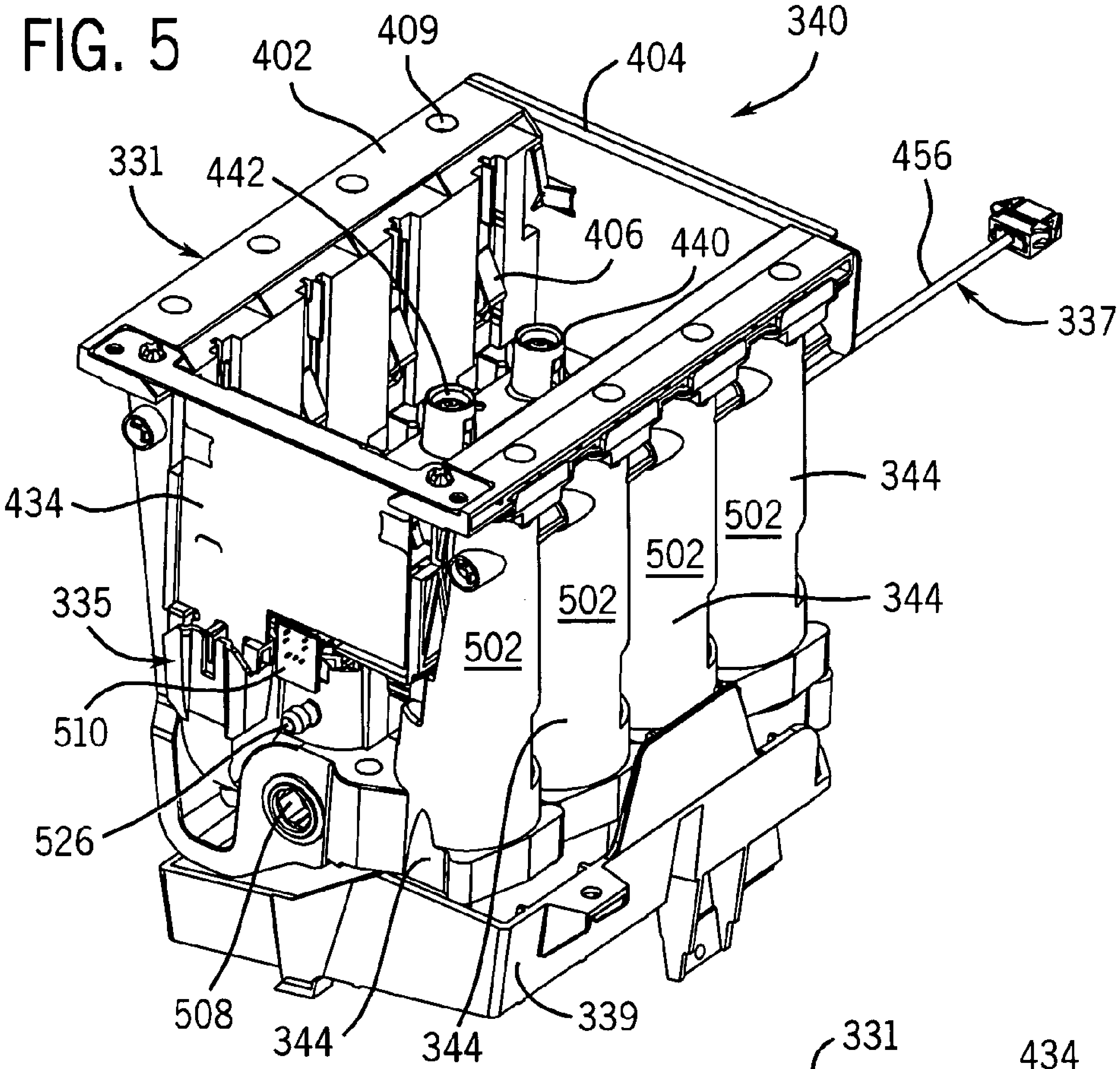
FIG. 5



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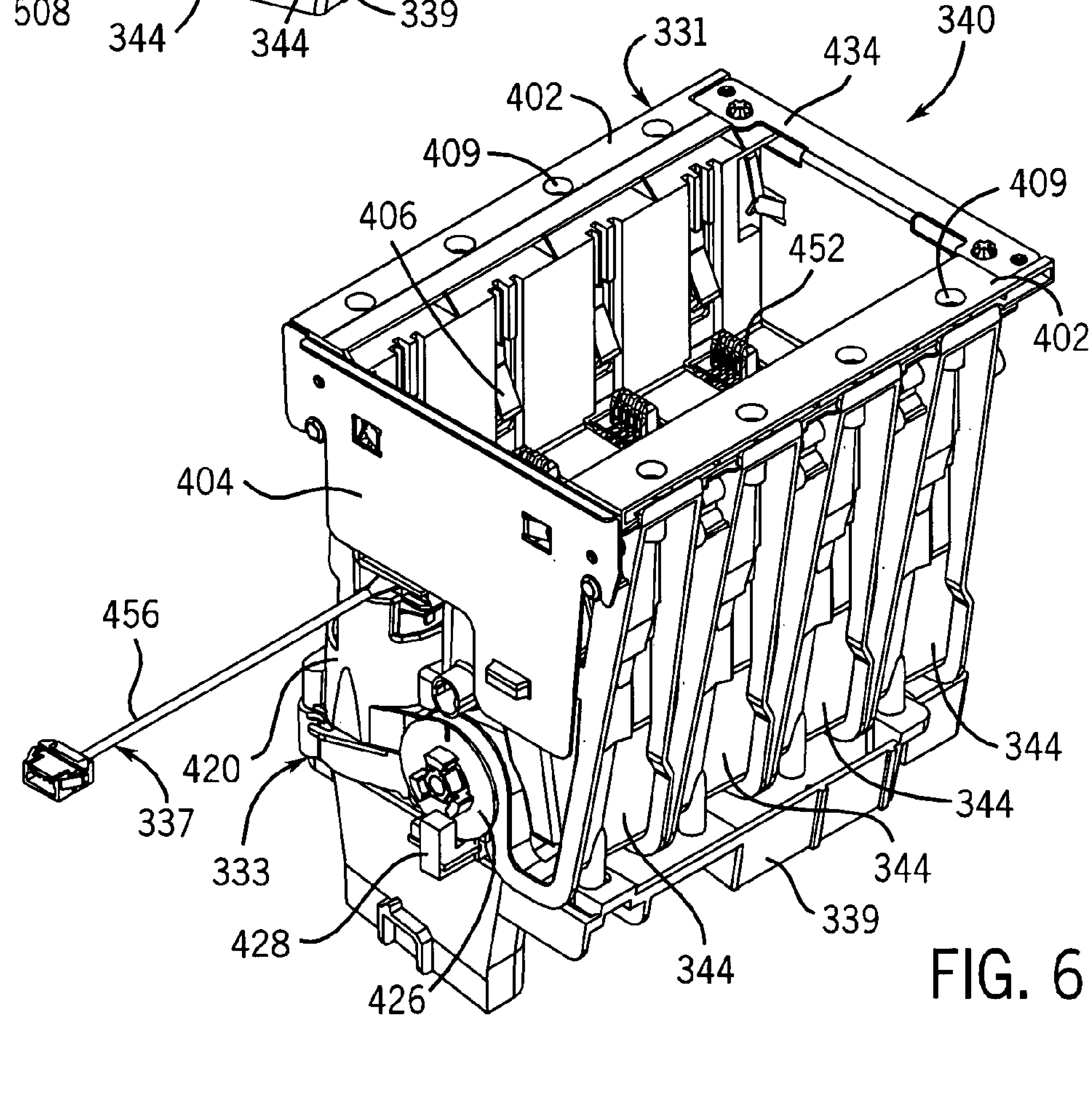

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FIG. 6

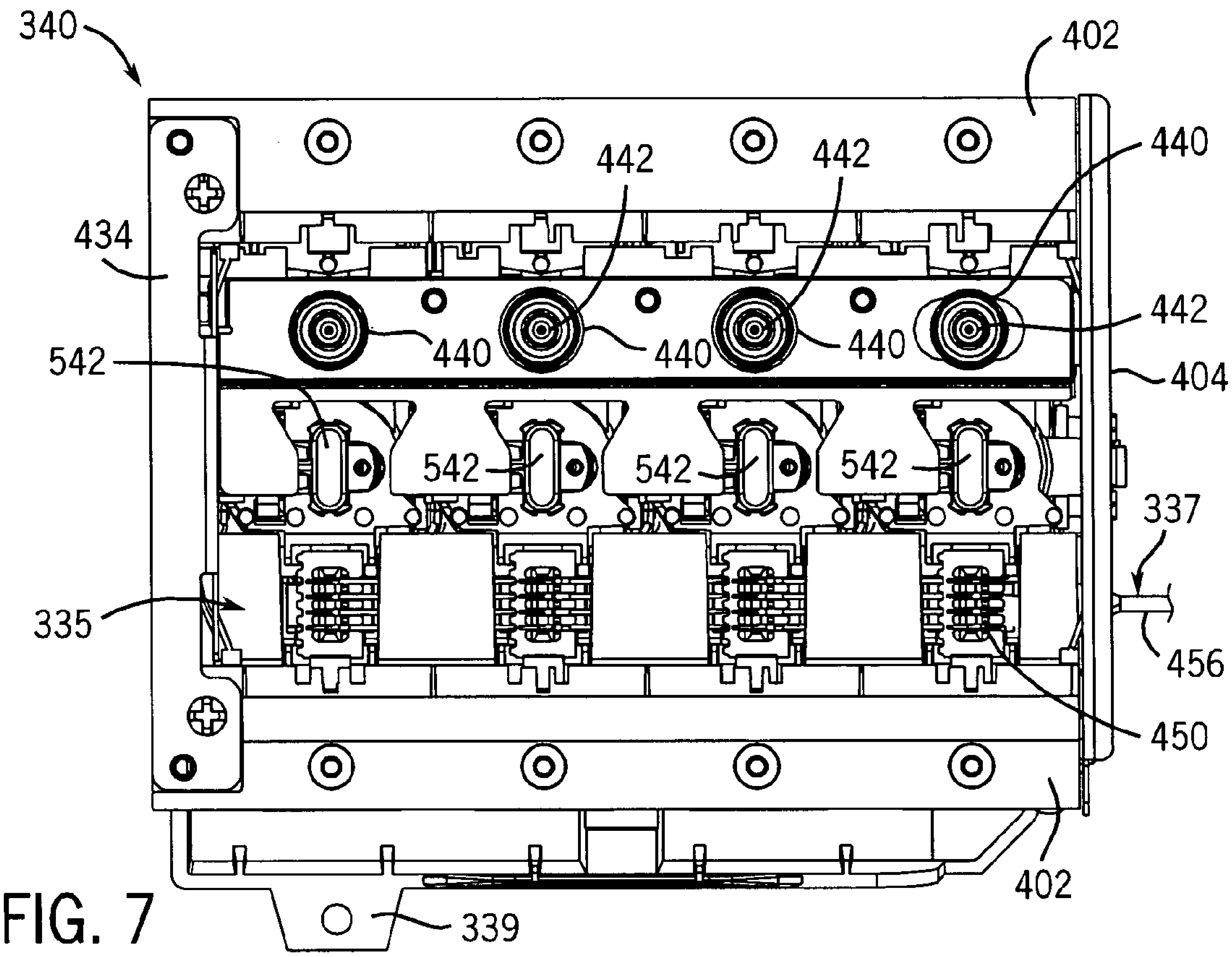
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FIG. 7

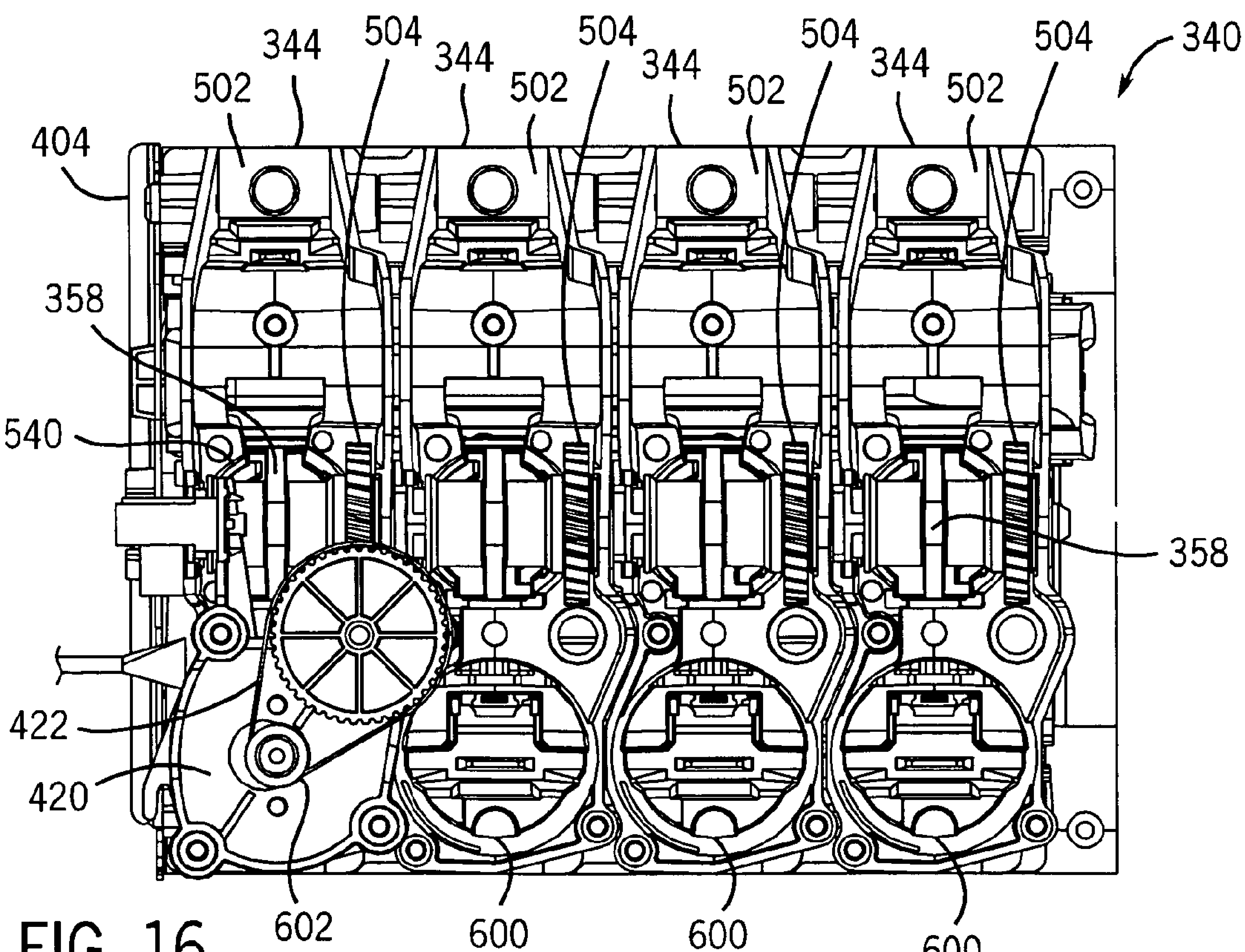
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FIG. 16

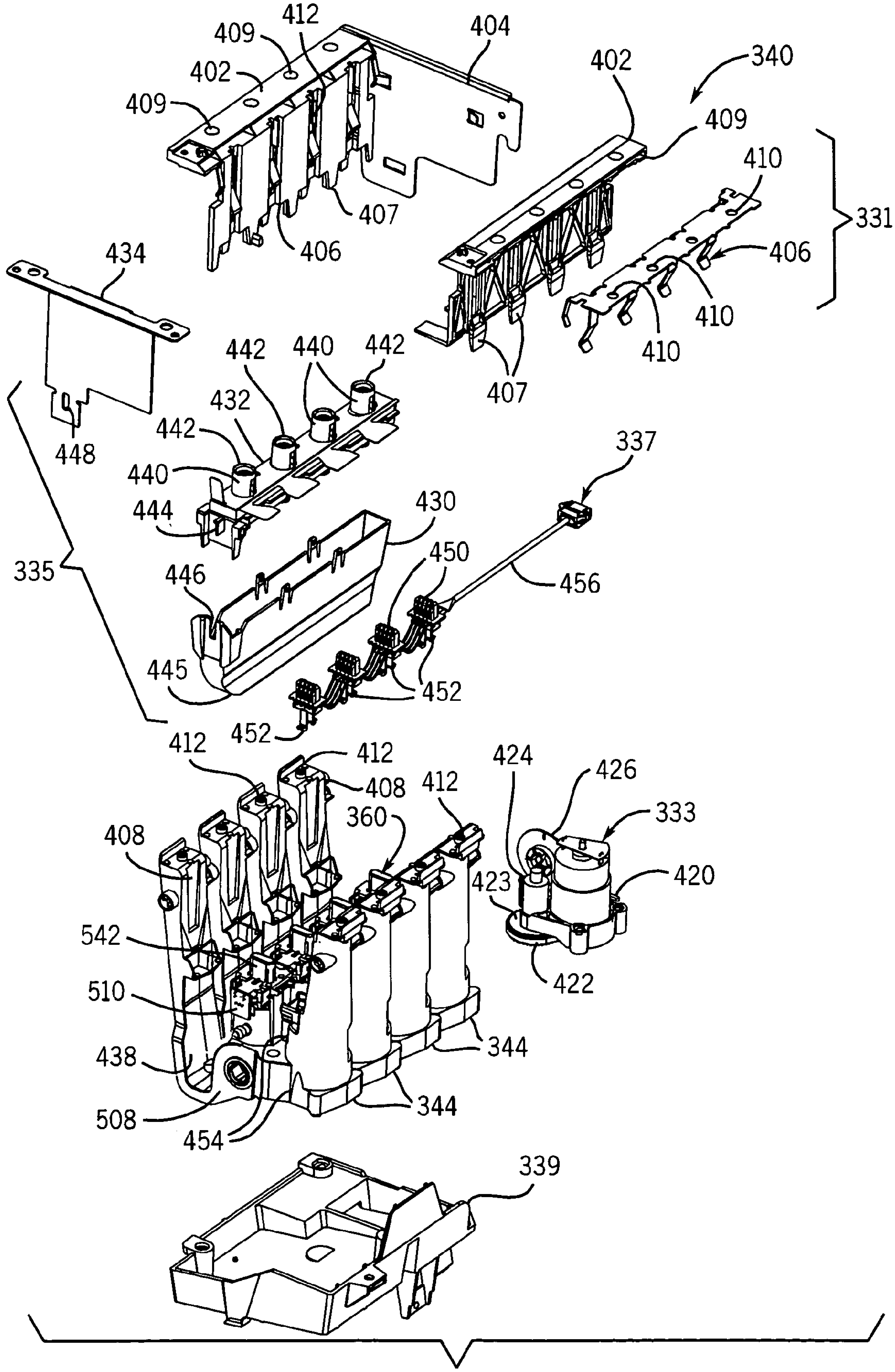

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FIG. 8

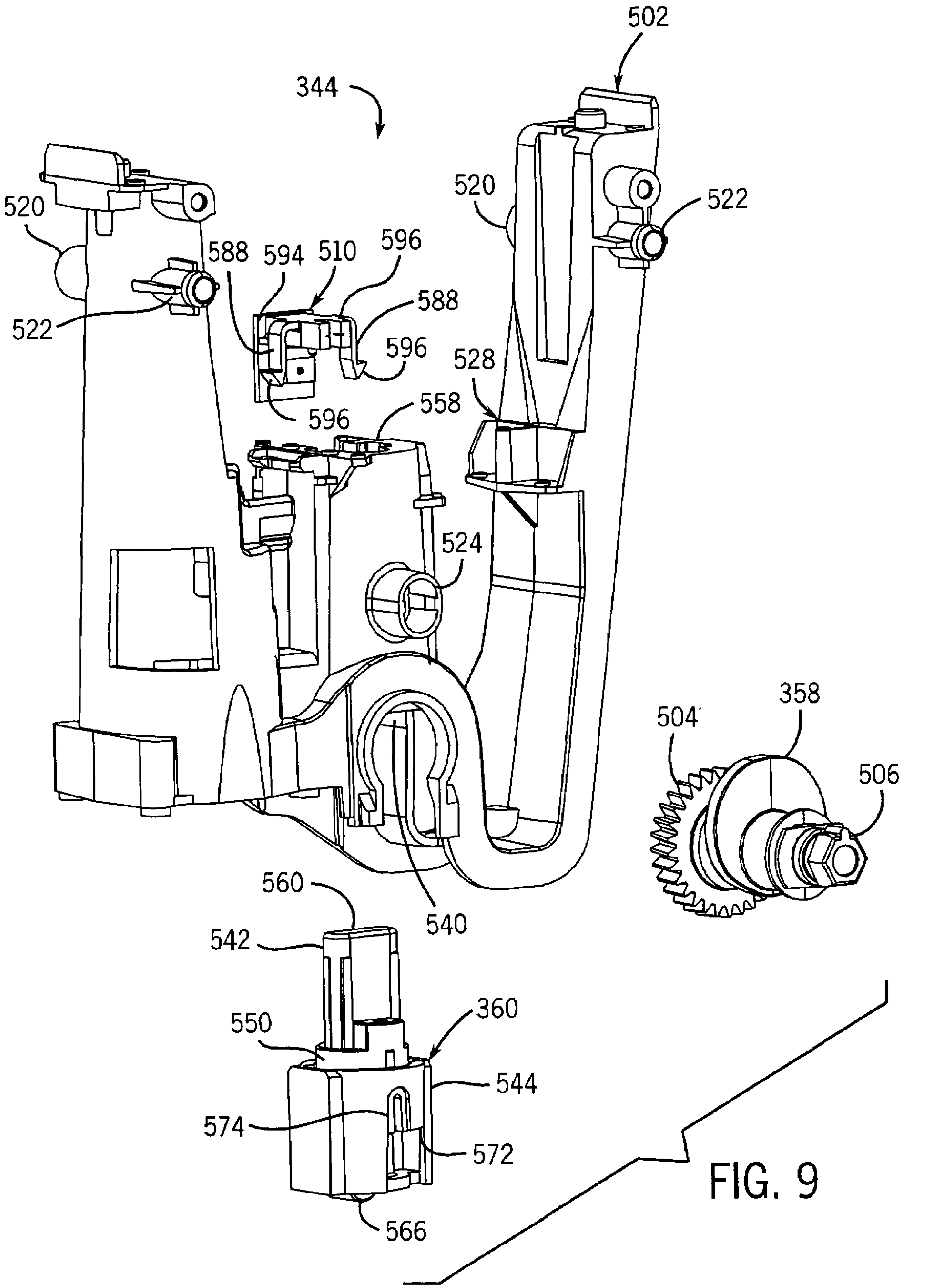

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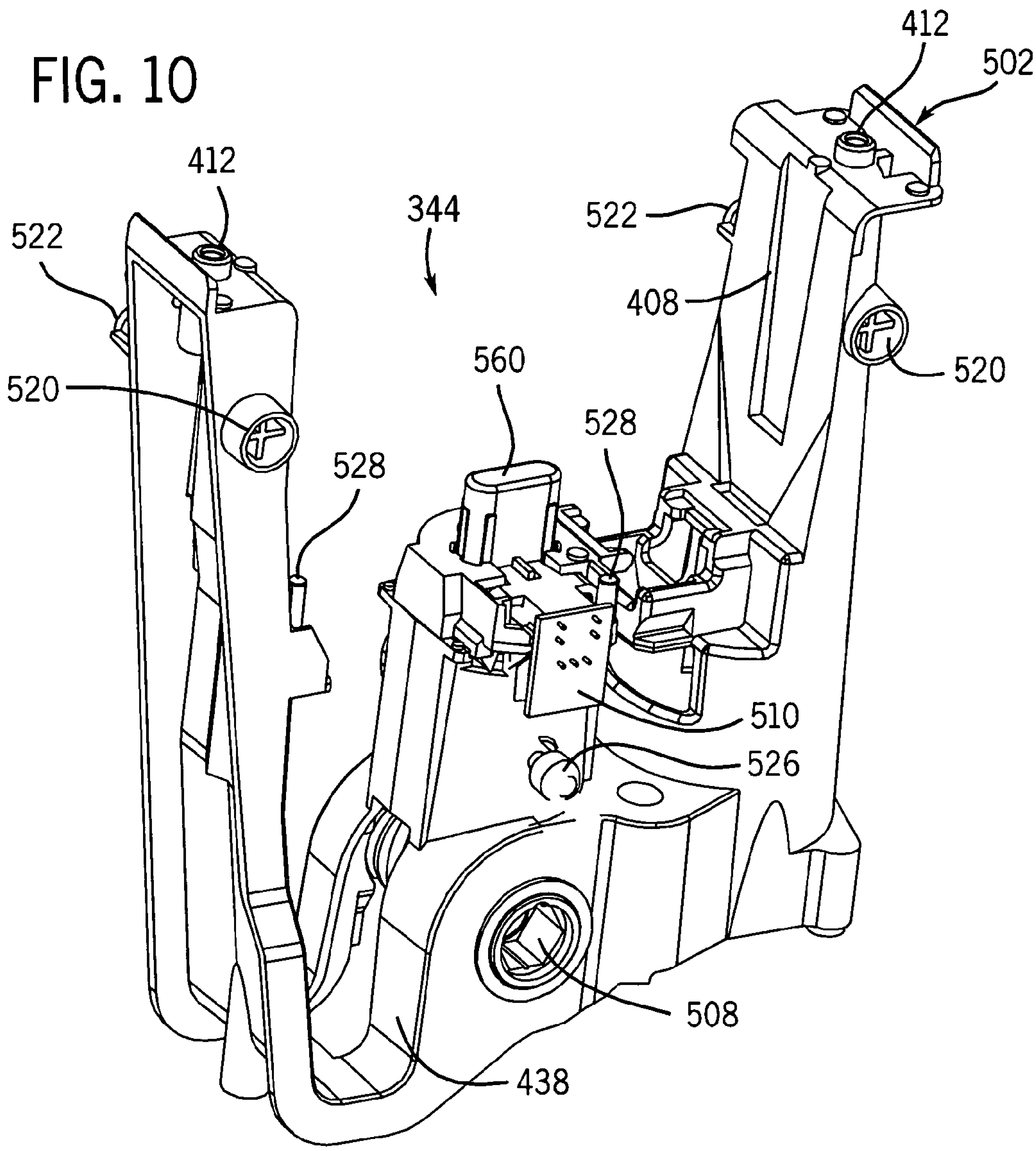
FIG. 9

FIG. 10



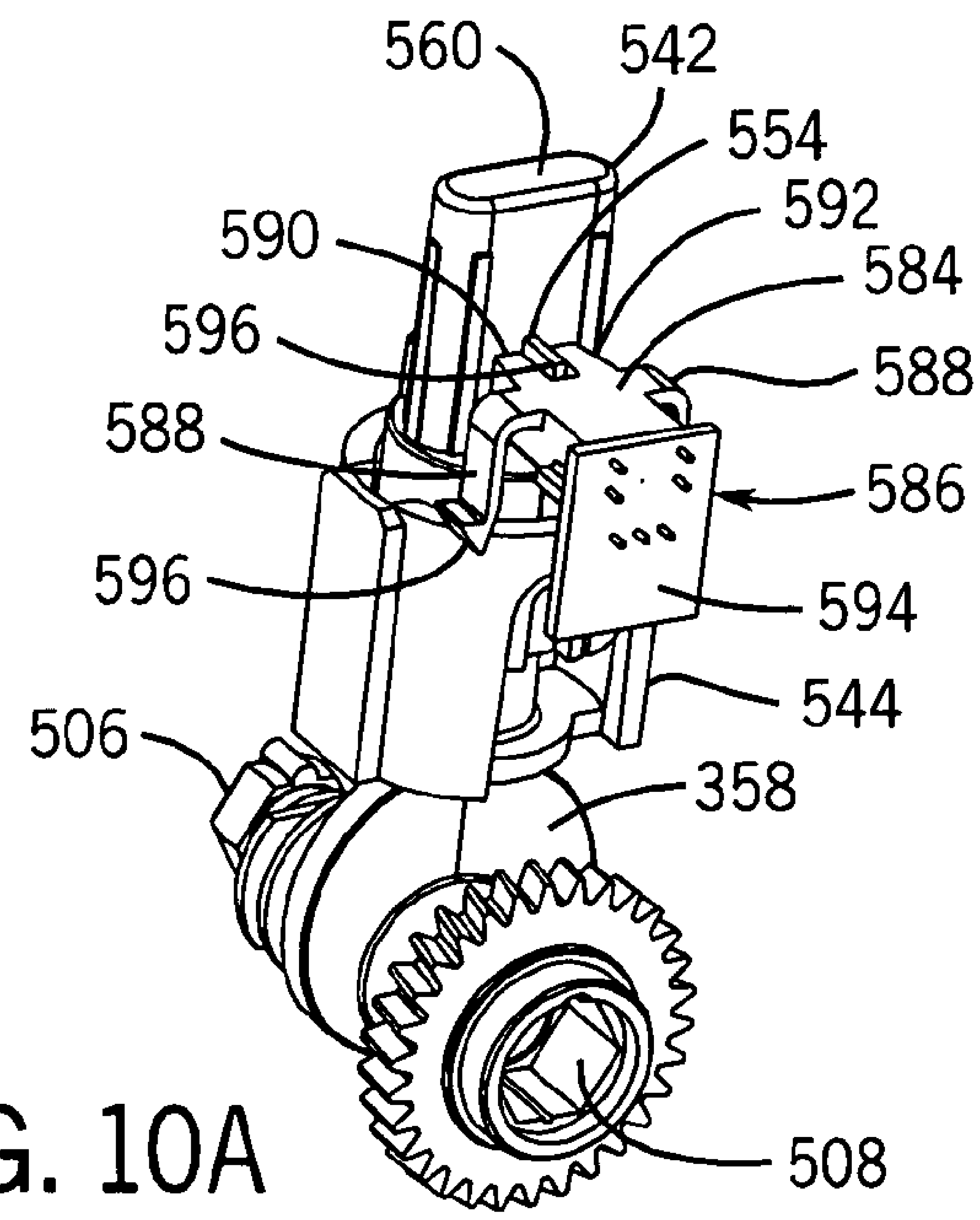
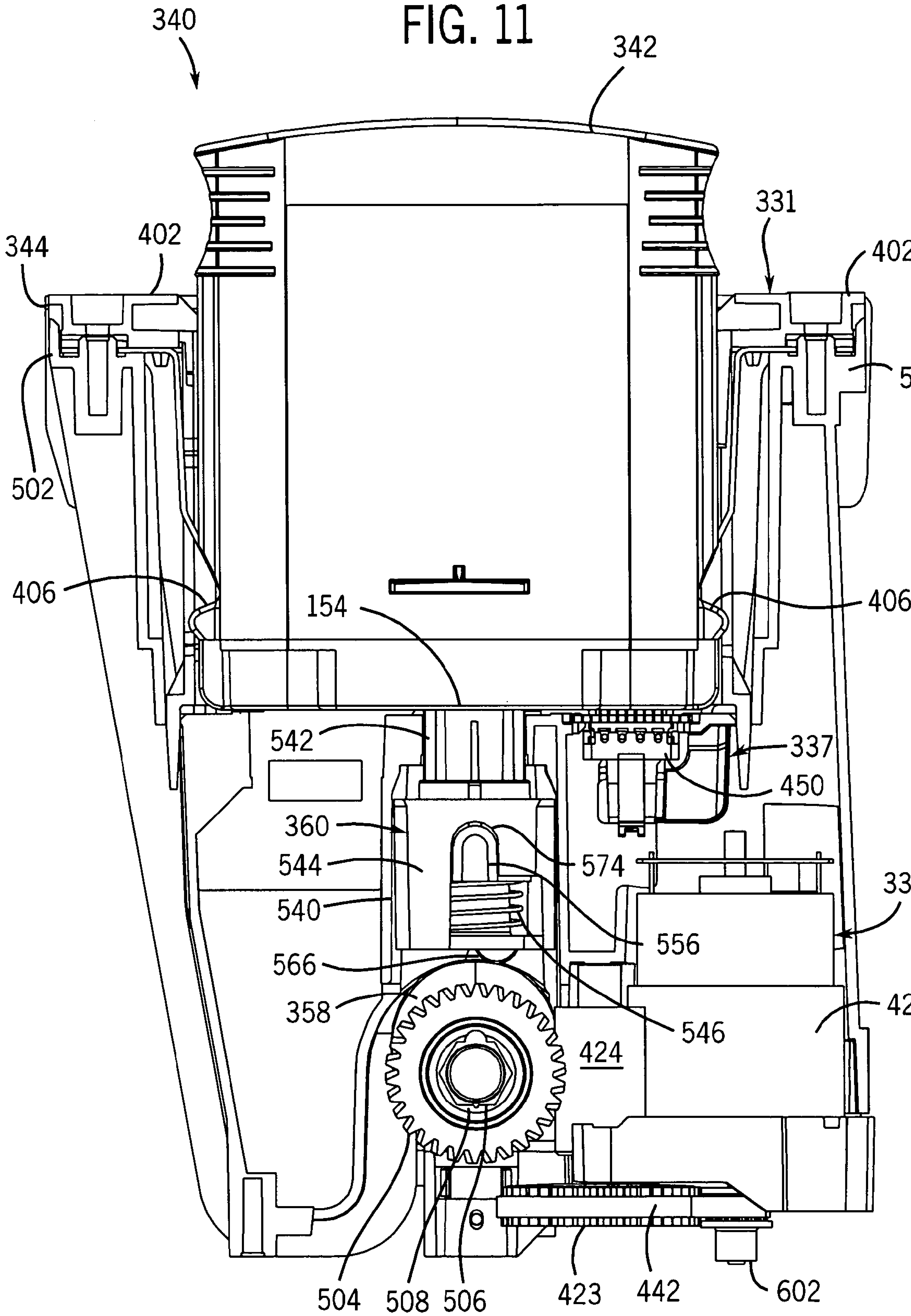


FIG. 10A

FIG. 11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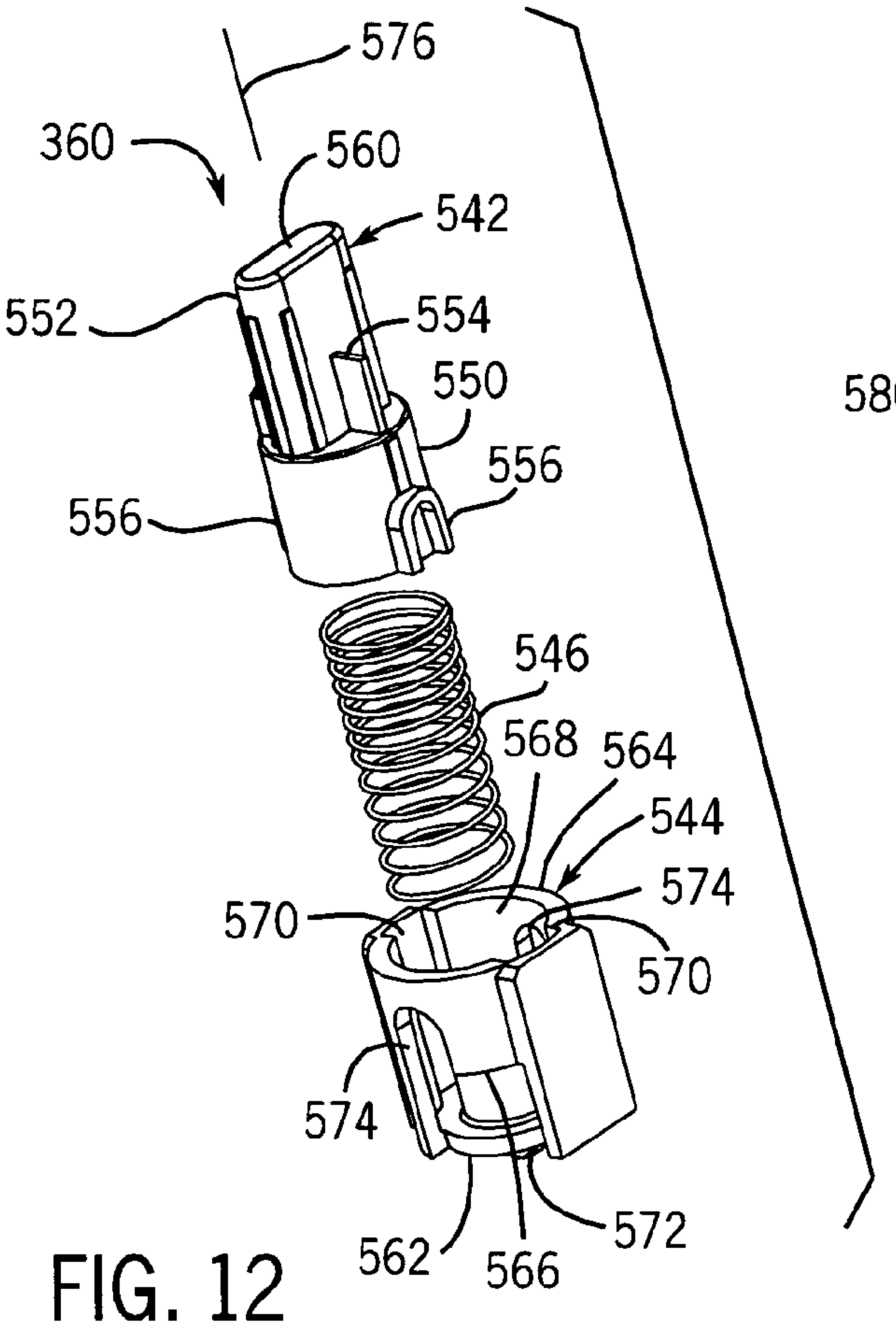


FIG. 12

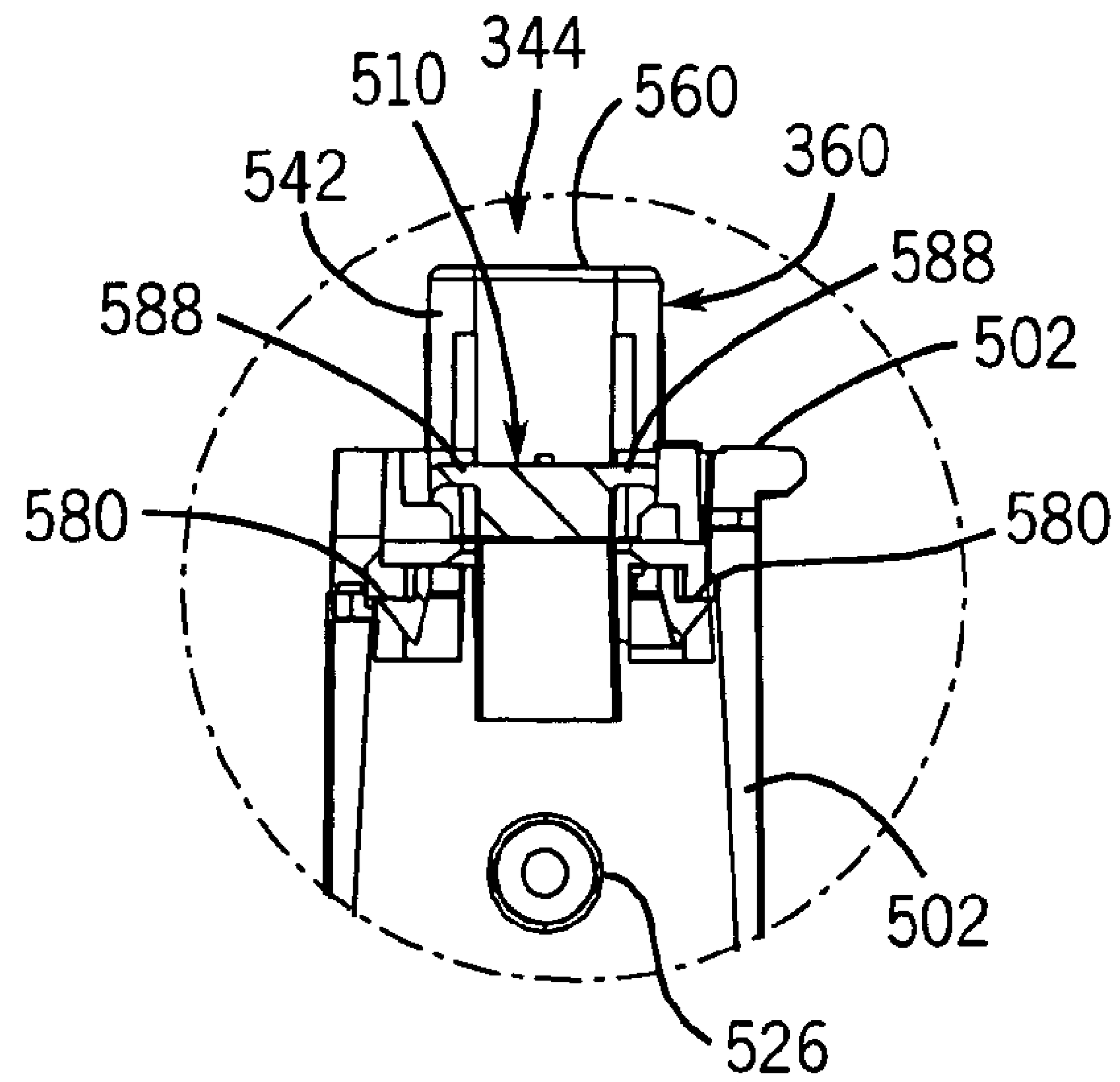
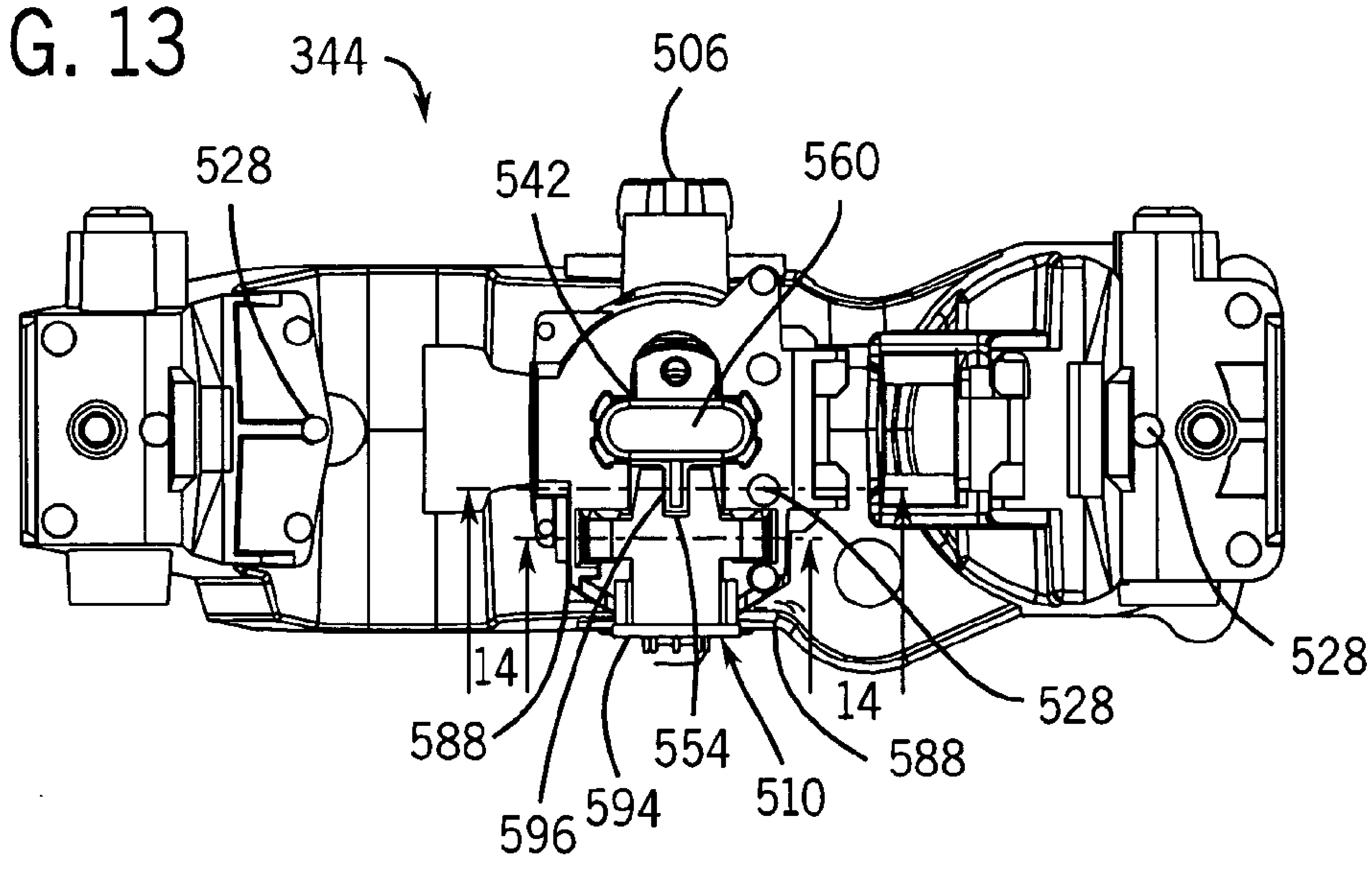


FIG. 14

FIG. 13



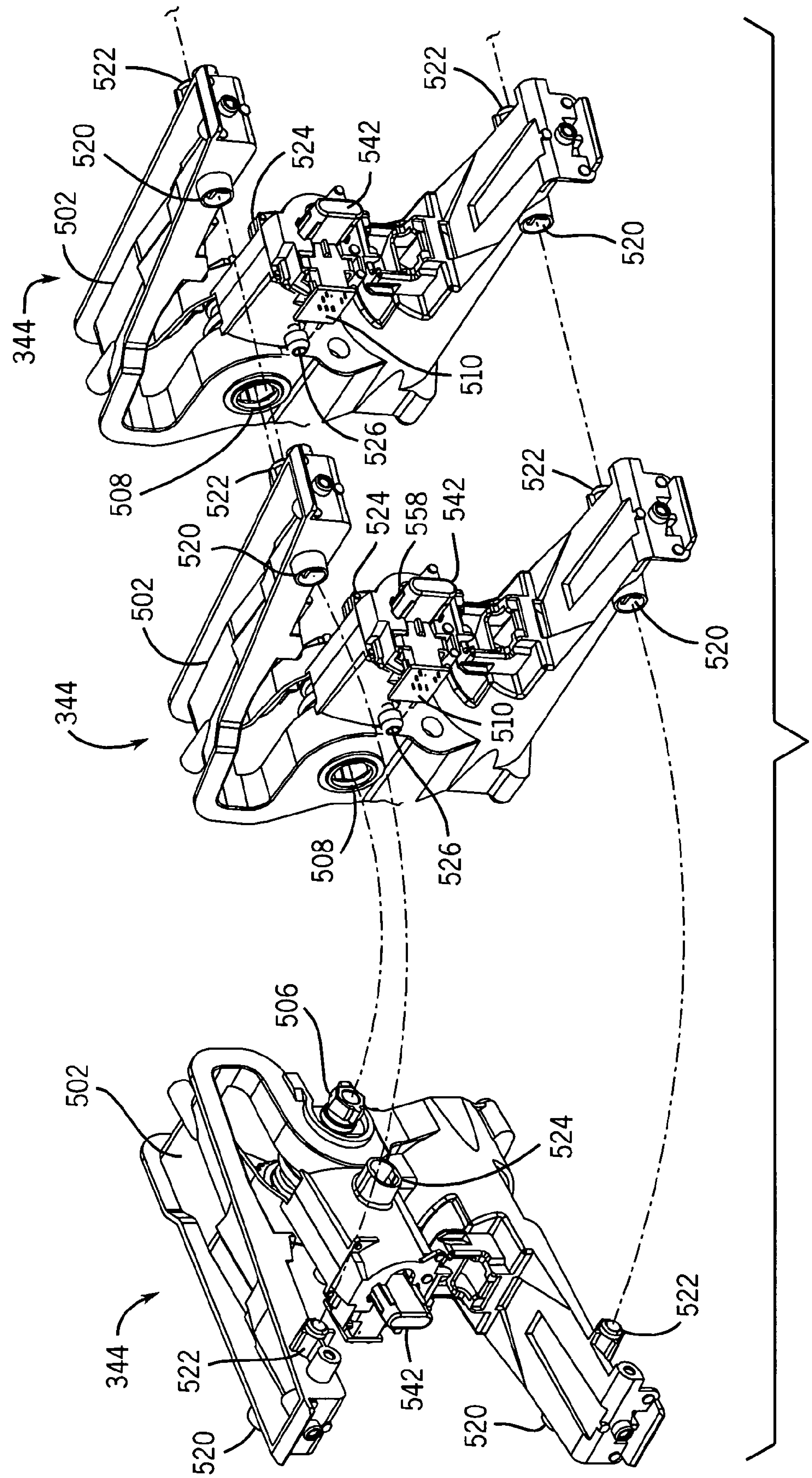

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FIG. 15

PRINTER INK SUPPLY SYSTEM

BACKGROUND OF THE INVENTION

Inkjet printers create an image by depositing liquid ink upon a medium. Such inkjet printers typically include a printhead and a reservoir or source of ink. In a first known inkjet printer, both the printhead and the ink reservoir are provided as a single print cartridge which is scanned across a page during printing. In a second known inkjet printer, only the printhead is scanned across the page. The ink reservoir is located off-axis and provides liquid ink to the printheads through flexible tubing extending between the ink reservoir and the printheads. U.S. Pat. No. 5,966,155 illustrates one example of a printer having an off-axis ink supply.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** schematically illustrates one example of a printer incorporating one example of an ink supply system of the present invention.

FIG. **2** schematically illustrates a first alternative embodiment of the ink supply system of FIG. **1**.

FIG. **3** schematically illustrates a second alternative embodiment of the ink supply system of FIG. **1**.

FIG. **4** is a top perspective view of one example of one embodiment of the printer shown in FIG. **1**.

FIG. **5** is a front perspective view of an ink supply station of the printer of FIG. **4**.

FIG. **6** is a rear perspective view of the ink supply station of the printer of FIG. **4**.

FIG. **7** is a top plan view of the ink supply station of the printer of FIG. **4**.

FIG. **8** is an exploded perspective view of the ink supply station of the printer of FIG. **4**.

FIG. **9** is a rear exploded perspective view of a single module of the ink supply station of the printer of FIG. **4**.

FIG. **10** is a rear perspective view of a single module of the ink supply station of FIG. **5**.

FIG. **10**A is a perspective view of a mechanical power transmission input portion, a mechanical power transmission output portion, a drive system, a pressurization system and a sensor of the module of FIG. **10**.

FIG. **11** is a fragmentary side elevational view of an ink supply system of the printer of FIG. **4**.

FIG. **12** is an exploded perspective view of the pressurization system of FIG. **10**A.

FIG. **13** is a top plan view of the module of FIG. **10**.

FIG. **14** is a sectional view of the module of FIG. **13** taken line **14**—**14**.

FIG. **15** is a top perspective view of the plurality of modules.

FIG. **16** is a bottom plan view of the ink supply station of FIG. **6** with a bottom plate omitted for purposes of illustration.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

FIG. **1** schematically illustrates printer **20** which generally includes media feeder **22**, carriage **24**, pens **26**, service station **28**, ink supply system **30** and controller **32**. Media feeder **22** comprises a conventionally known or future developed drive configured to move a medium, such as paper, relative to pens **26**. Pens **26** may also be referred to as print cartridges. Carriage **24** comprises a conventionally known or future developed carriage configured to move pens

26 relative to the medium being supplied and moved by feeder **22**. In the particular embodiment illustrated, media feeder **22** moves paper in the direction indicated by arrow **34** while carriage **24** moves pens **26** in the directions indicated by arrows **36**. Service station **28** comprises a conventionally known or future developed printer station including devices configured to perform servicing operations upon pens **26** between printing operations. Examples of such service operations include wiping and capping.

Ink supply system **30** supplies fluid ink to pens **26** through tubing **38**. Ink supply system **30** generally includes ink supply station **40** and ink supplies **42**. As will be described in greater detail hereafter, ink supply station **40** is formed from a plurality of distinct modules **44** releasably coupled to one another. For purposes of this disclosure, the term "coupled" shall mean the joining of two members directly or indirectly to one another. Such joining may be stationary in nature or movable in nature. Such joining may be achieved with the two members or the two members and any additional intermediate members being integrally formed as a single unitary body with one another or with the two members or the two members and any additional intermediate member being attached to one another. Such joining may be permanent in nature or alternatively may be removable or releasable in nature. In one embodiment, modules **44** are directly coupled or connected to one another. In another embodiment, modules **44** are indirectly coupled to one another by means of an intermediate framework.

Each module **44** includes one or more of the components that are generally necessary per each ink supply **42**. In other words, those components or devices which must be individually provided for each ink supply **42** are singulated or separated and provided by each module **44**. In contrast, one or more of the components or devices which are commonly shared or used by all of ink supplies **42** are generally provided only once, eliminating redundancy. As a result, ink supply station **40** may be easily reconfigured to accommodate varying numbers of ink supplies **42** by adding or removing individual modules **44** to ink supply station **40**.

Controller **32** generally comprises a processor unit configured to generate control signals which are transmitted to media feeder **22**, carriage **24**, pens **26**, service station **28** and ink supply system **30** as indicated by communication lines **48**. For purposes of this disclosure, the term "processor unit" shall mean a conventionally known or future developed processing unit that executes sequences of instructions contained in a memory. Execution of the sequences of instructions causes the processing unit to perform steps such as generating control signals. The instructions may be loaded in a random access memory (RAM) for execution by the processing unit from a read only memory (ROM), a mass storage device, or some other persistent storage. In other embodiments, hard wired circuitry may be used in place of or in combination with software instructions to implement the functions described. Controller **32** is not limited to any specific combination of hardware circuitry and software, nor to any particular source for the instructions executed by the processing unit.

Although ink supply system **30** is illustrated in conjunction with printer **20** having pens **26** which are moved or scanned across the medium, ink supply system **30** may alternatively be employed in printers having pens in which the pens are held stationary as the medium is moved relative to the pens. One example of such a printer is a page-wide array printer. In particular applications, ink supply system may be utilized with other image-forming devices wherein fluid ink is deposited upon a medium by means other than pens or printheads or wherein the medium itself is held generally stationary as the ink is deposited upon the medium. Overall, ink supply system **30** may be utilized in any image-forming device which utilizes ink.

FIG. **2** illustrates ink supply system **130**, an example of one embodiment of ink supply system **30**. Ink supply system **130** generally includes support frame **131**, power source **133**, power transmission **135** having output portions **137**, ink supplies **42** and ink supply station modules **144**. Support frame **131** generally comprises a structure or housing which joins and supports power source **133** and transmission **135**. Support frame **131** further removably receives and supports modules **144** and ink supplies **42**. Although not illustrated, frame **131** may also support conventionally known acumen connectors for each ink supply **42**.

Power source **133** comprises a conventionally known or future developed device configured to provide power such as torque, fluid or pneumatic pressure, or electrical power for driving each of modules **144**. Power source **133** supplies power to transmission **135** via output portion **145**.

Transmission **135** transmits the power from power source **133** to each of modules **144**. Output portions **137** generally include couplings **147** configured to releasably interlock or releasably mate with corresponding couplings associated with each of modules **144**.

Ink supplies **42** comprise conventionally known or future developed ink supplies fluidly coupled to pens **26**. For purposes of this disclosure, the terms "fluidly coupled" or "in fluid communication" means that two or more members having fluid containing volumes that are connected to one another by one or more fluid passages enabling fluid to flow between the volumes in one or both directions. Such fluid flow may be temporarily cessated by selective actuation of valve devices. In the embodiment illustrated, ink supplies **42** are configured to supply fluid ink through a plurality to tubes **38** to pens **26** (shown in FIG. **1**). Each ink supply **42** generally includes an ink reservoir **150**, a fluid passage **152** extending from reservoir **150** to tube **38** and a flexible diaphragm **154** (sometimes known as a bongo). Movement of diaphragm **154** pressurizes fluid ink along passage **152** to move the ink through tube **38** to pens **26**. Fluid passage **152** may be temporarily occluded at points between reservoir **150** and pens **26** during the supply of ink to pens **26**. Examples of an ink supply **42** are disclosed in U.S. Pat. No. 5,971,529 entitled "Automatic Ink Interconnect Between Print Cartridge and Carriage" and U.S. Pat. No. 5,966,155 entitled "Inkjet Printing System With Off-Axis Ink Supply Having An Ink Path Which Does Not Extend Above Print Cartridge," the full disclosures of which are hereby incorporated by reference.

Modules **144** comprise distinct individual units configured to be releasably mounted to frame **131** and further configured to interact with diaphragms **154** to pressurize ink and move ink through tubes **38**. Each module **144** generally includes a body, frame or chassis **155**, a power transmission input portion **157**, drive mechanism **158** and a pressurization system **160**. Chassis **155** generally comprises a structure or framework supporting the remaining components of module **144**. Chassis **144** may have a variety of different sizes, shapes and configurations depending upon the exact characteristics of module **144**. Power transmission input portion **157** generally comprises a coupling **161** configured to releasably interlock or releasably mate with coupling **147** of output portion **137** so as to transmit power from transmission **135** to drive mechanism **158**.

Drive mechanism **158** generally comprises a structure configured to convert the power or energy supplied to it through transmission **135** and coupling **161** into a force by which pressurization system **160** interacts with diaphragm **154** to move diaphragm **154**. The actual configuration of drive mechanism **158** may vary depending upon the form of the energy or power being provided to drive mechanism **158**. For example, drive mechanism **158** may comprise a cam wherein the power is in the form of mechanical torque, a piston wherein the power is in the form of a pressurized gas or fluid or a solenoid or other electrically driven device wherein the power is in the form of electrical power.

Pressurization system **160** comprises a mechanical device configured to be driven by drive mechanism **158** to interact with diaphragm **154** so as to move diaphragm **154**. Pressurization system **160** includes a movable member supported by module **144** so as to move while in engagement with diaphragm **154** to move diaphragm **154**.

In one embodiment, power source **133** may comprise a motor configured to generate rotational mechanical energy or torque which is transmitted by transmission **135**, comprising a power train, to each of force couplings **147** which mate with force couplings **161**. Drive mechanism **158** may comprise a cam which is rotatably driven by the rotational mechanical energy to move the movable member of pressurization system **160** while the movable member is in engagement with flexible membrane **154**.

In another embodiment, power source **133** may comprise a hydraulic or pneumatic pump, wherein transmission **135** comprises a pneumatic or fluid conduit. Couplings **147** and **161** may be configured to transmit pneumatic or fluid pressure from source **133** to drive mechanism **158** comprising a piston, wherein pressurization system **160** includes a movable member coupled to the piston. Supply of pressurized gas or fluid against the piston moves the movable member while the movable member is in engagement with the diaphragm **154**.

In yet another alternative embodiment, power source **133** may comprise a source of electrical power, wherein transmission **135** comprises an electrical power transmitting line. In such an embodiment, couplings **147** and **161** are configured to provide electrical interconnection between transmission **135** and each of modules **144**. Electrical power transmitted to each of modules **144** is supplied to drive mechanism **158** comprising a solenoid. The supply of electrical power to the solenoid causes the solenoid to move the movable member of pressurization system **160** while in engagement with the diaphragm **154**.

As illustrated by the module **144** and ink supply **42** shown in phantom in FIG. **2**, ink supply station **140** may be easily reconfigured to accommodate a varying number of ink supplies **42**. In particular, to add an additional ink supply, an additional module **144** may be releasably coupled to frame **131** with power transmission input portion **157** coupled to power transmission output portion **137**. In particular applications, frame **131** may also need to be reconfigured to provide additional power output portions **137**. Even if frame **131** also needs to be reconfigured, system **130** enables the same modules **144** to be employed. As a result, ink supply station **140** provides ink supply system **130** with improved versatility.

FIG. **3** schematically illustrates ink supply system **230**, an alternative embodiment of ink supply system **130**. Ink supply system **230** is similar to ink supply system **130** except that ink supply system **230** includes ink supply station **240** having modules **244** in lieu of modules **144**. For ease of illustration, those remaining elements of ink supply system **230** which correspond to elements of ink supply system **130** are numbered similarly. Each of modules **244** generally includes transmission input portion **257**, power transmission output portion **247** and pressurization system **160**. Power transmission input portion **257** comprises a structure configured to facilitate the input of power to module **244**. Power transmission output portion **247** is operably coupled to one or both of input portion **257** and pressurization system **160** and is configured to output power from module **244**. As a result, modules **244**, themselves, provide at least a portion of the transmission for transmitting power from power source **133** to each of pressurization systems **160** and to adjacent modules **244**. In one embodiment, power transmission output portion **247** is configured to be releasably connected to a power transmission input portion **257** of an adjacent module **244**.

As shown by FIG. **3**, power transmission input portion **257** of an endmost module **244** is releasably coupled to power source **133**. In alternative embodiments, this endmost module **244** may be permanently secured to power source **133**. The opposite endmost module **244** is illustrated as including an unconnected power transmission output portion **247**. In particular embodiments, this module may be configured so as to omit the power transmission output portion **247**.

In one particular embodiment, ink supply station **240** includes a frame **231** to which modules **244** are releasably coupled. Modules **244** may additionally include mating structures configured to locate modules **244** adjacent to one another. In yet an alternative embodiment, ink supply station **240** may omit frame **231**, wherein modules **244** are releasably connected to one another to form a single overall unit configured to receive or be releasably connected to ink supplies **42**.

As shown by the module **244** and its ink supply **42** illustrated with phantom lines, ink supply station **240** may be easily reconfigured to accommodate varying numbers of ink supplies **42**. In particular, adding an ink supply requires that an additional module **244** be releasably coupled to either an adjacent module **244** or to a frame **231** (if provided). In particular applications, an alternative frame **231** providing additional locations for additional modules **244** may be required. In still other embodiments, frame **231** may be configured to be releasably coupled to a frame extension which provides additional locations for additional modules **244**.

Because the overall transmission **235** extending from power source **133** to pressurization systems **160** is in part provided by modules **244** themselves, frame **231** may be omitted or may be provided with a much reduced complexity as compared to frame **131**. Modules **244** may be connected directly to one another to provide a single power transmission between each of pressurization systems **160** from a single power source **133**.

In one embodiment, power source **133** comprises a motor configured to generate rotational mechanical energy or torque. Transmission **135** comprises a power train formed by gears and shafts provided in each of modules **244**. Pressurization system **160** comprises a movable member in engagement with flexible diaphragm **154** and a drive mechanism **158**, such as a cam, which is driven by the rotational mechanical energy from power source **133**.

In another embodiment, power source **133** may comprise a source of pressurized gas or fluid such as a pneumatic or hydraulic pump. Transmission **235** comprises a pneumatic or hydraulic conduit, wherein input portion **257** and output portion **247** comprise pneumatic or hydraulic couplings. Drive mechanism **158** comprises a piston. Pressurization system **160** includes a movable member coupled to the piston and in engagement with flexible diaphragm **154**.

In still another embodiment, power source **133** comprises a source of electrical power and transmission **235** comprises an electrically conductive line. Input portion **257** and output portion **247** comprise electrical connectors. Drive mechanism **158** comprises a solenoid. Pressurization system **160** includes a movable member coupled to the solenoid and in engagement with flexible diaphragm **154**.

FIGS. **4**–**16** illustrate printer **320**, a detailed embodiment of printer **20** shown in FIG. **1**. For purposes of illustration, portions of printer **320** are omitted. Printer **320** includes media feeder **322**, carriage **324**, pens **326**, service station **328** and ink supply system **330**. Media feeder **22** comprises a drive configured to move a medium, such as paper, relative to carriage **324** and pens **326**. Carriage **324** comprises a device configured to move pens **326** relative to the medium being supplied and moved by feeder **322**. In the particular embodiment illustrated, carriage **324** includes a belt or cable **329** which is driven to move pens **326**. Service station **328** performs servicing operations upon pens **26** between printing operations.

Ink supply system **330** includes ink supply station **340** and a plurality of ink supplies **342** (one of which is shown). An example embodiment of ink supplies **342** are shown and described in U.S. Pat. No. 5,971,529, the full disclosure of which is hereby incorporated by reference. Ink supply **42** includes a flexible diaphragm **154** (schematically shown in FIG. **3**) by which fluid ink contained within a fluid passage is pressurized. Ink supply station **340** provides a structure for supporting and at least partially housing ink supplies **342** and for delivering ink from ink supplies **342** to pens **326** through tubing **38** (shown in FIG. **1**). In the particular embodiment illustrated, each ink supply **342** has an individual tube **38** connected to a dedicated pen **326**.

FIGS. **5**–**8** illustrate ink supply station **340** in greater detail. As shown by FIG. **8**, ink supply station **340** generally includes support frame **331**, motor assembly **333**, ink delivery system **335**, acumen connector assembly **337**, bottom plate **339** and modules **344**. Support frame **331** comprises a structure configured to support modules **344** in position relative to one another. Support frame **331** also is configured to align and position ink supplies **342** (shown in FIG. **4**) within station **340**. In the particular embodiment illustrated, support frame **331** includes key walls **402**, end plate **404** and springs **406**. Key walls **402** support spring **406** and are interconnected to one another by end plate **404**. Springs **406** pass through bores **412** within key walls **402** so as to resiliently engage ink supplies **42**. Springs **406** assist in aligning and securing ink supplies **42** within station **340**.

Key walls **402** include downwardly projecting tabs **407** which mate with corresponding slots **408** provided on modules **344** to secure modules **344** relative to one another. Key walls **402** additionally include apertures **409** through which fasteners extend into aligned apertures **410** in springs **406** and into aligned bores **412** provided on modules **344**.

In alternative embodiments, key walls **402** may be coupled to one another by means other than plate **404**. Springs **406** may be secured to key walls **402** by means other than fasteners. In particular embodiments, key walls **402** and springs **406** may be integrally formed as part of a single unitary body. In alternative embodiments, support frame **331** may include other structures or components which releasably secure modules **344** relative to one another. Although springs **406** are illustrated as being supported by key walls **402**, springs **406** may alternatively be reconfigured and provided by each of modules **344**. In still other embodiments, support frame **331** may be omitted wherein modules **344** are directly coupled and releasably fastened to one another.

Motor assembly **333** (also known as a power train assembly) is coupled to an end-most one of modules **344**. In alternative embodiments, motor assembly **333** may alternatively be supported by an alternatively configured support frame **331**. Motor assembly **333** comprises a power source configured to provide rotational mechanical energy or torque to a drive train provided by the interconnection of modules **344**. Motor assembly **333** generally includes motor **420**, toothed belt **422**, gear **423**, worm gear **424**, encoder wheel **426** and a optical sensor **428** (shown in FIG. **6**). Motor **420** comprises an electric motor having an output shaft which rotatably drives toothed belt **422** coupled to gear **423**. Worm gear **424** is coupled to gear **423** and functions as a mechanical power transmission output portion of assembly **333**, Worm gear **424** engages a mechanical power transmission input portion of one of modules **344** to transmit torque from motor **420**. Worm **421** further rotatably drives encoder wheel **426**. Encoder wheel **426** rotates and passes between a photo emitter and a photo receiver of an optical sensor **428** (shown in FIG. **6**) to generate signals which are transmitted to a controller **32** (shown in FIG. **1**) to assist in controlling motor **420**. In alternative embodiments, encoder wheel **426** and the optical sensor **428** may be omitted wherein motor **420** alternatively comprises a stepper motor. In lieu of belt **422** and worm gear **424**, alternative mechanical torque transmission components may be utilized such as intermeshing gears, chain and sprocket assemblies or other belt and pulley arrangements.

Ink delivery system **335** generally comprises one or more structures configured to deliver ink from ink supplies **342**. System **335** includes housing **430**, port assembly **432** and end plate **434**. Housing **430** provides a structure in which tubes **38** are contained and are connected to port assembly **432**. Housing **430** includes a bottom opening **445** through which tubes **38** pass into channel **438** and extend to pens **326**. Housing **430** is partially received within channel **438** of each of modules **344**.

Port assembly **432** provides a fluidic interconnection to each of ink supplies **342** (shown in FIG. **4**). Port assembly **432** includes a plurality of alignment structures **440** and needles **442**. Alignment structures **440** align and mate needles **442** to corresponding septums provided on ink supplies **342**. Needles **442** are in fluid communication with tubes **438**.

End plate **434** is fixedly coupled to housing **430** and port assembly **432** by means of tab **444** which projects through openings **446** and opening **448**. End plate **434** is configured to be secured to key walls **402** of support frame **331**.

Although ink distribution system **335** is illustrated as including the individual components shown which are coupled to one another, ink supply system **335** may alternatively be provided by a greater or fewer number of components or may utilize other conventionally known or future developed means for providing a fluidic interconnection to each of ink supplies **342**.

Acumen connector assembly **337** is conventionally known and is configured to connect to the acumen or memory of each individual ink supply **42**. In the particular embodiment, acumen connector assembly **337** includes individual acumen connectors **450** having prongs **452** which snap into place between support legs **454** on each of modules **344**. Acumen connector assembly **337** includes a communication cable **456** configured to connect to and communicate with controller **32** (shown in FIG. **1**).

Bottom plate **339** comprises a structure configured to be releasably mounted to a lower surface of modules **344**. Bottom plate **339** further secures modules **344** relative to one another. In addition, bottom plate **339** serves as structure for releasably mounting ink supply station **340** to the remainder of printer **320**.

Modules **344** comprise distinct units releasably coupled to one another and configured to interact with ink supplies **42** to pressurize and pump fluid ink from ink supplies **42**. In the particular embodiment illustrated, each of modules **344** is substantially identical to one another. In alternative embodiments, modules **344** may have varying configurations. For example, in one alternative embodiment, one module **344** may be configured to interact with a first type of ink supply while another module **344** is configured to interact with a second type of ink supply.

FIGS. **9**–**14** illustrate one of modules **344** in greater detail. As best shown by FIG. **9**, module **344** generally includes chassis **502**, mechanical power transmission input portion **504**, mechanical power transmission input portion **506**, mechanical power transmission output portion **508** (shown in FIG. **10**) drive mechanism **358**, pressurization system **360** and sensor **510**. Chassis **502** is a structure configured to support and carry the remaining components of module **344**. In the particular embodiment illustrated, chassis **502** is also configured to locate module **344** relative to frame **331**, to locate module **344** relative to adjacent modules **344** and to locate an ink supply **342** relative to ink supply station **340**. In alternative embodiments such additional functions may be provided by other structures.

In addition to slots **408**, bores **412** and channel **438** described above, chassis **502** includes module locators **520**, **522**, **524**, **526**, and ink supply locations or datums **528**. Locators **520** and **522** extend on opposite sides of chassis **502**. Locators **520** and **522** are configured to mate with opposite extending locators on adjacent modules. In the particular embodiment illustrated in which modules **344** are substantially identical to one another, locators **520** are configured to mate with locators **522**. Locators **524** and **526** extend on opposite sides of chassis **502** and are configured to mate with opposite locators provided on adjacent modules **344**. In the particular embodiment illustrated in which modules **344** of ink supply station **340** are substantially identical to one another, locator **526** is configured to mate with locator **524**. Overall, locators **520**, **522**, **524** and **526** facilitates proper alignment of chassis **502** of adjacent modules **344**.

Ink supply datums **528** generally comprise surfaces provided by chassis **502** which are located so as to engage or abut a lowermost floor surface of an ink supply **342**. Datums **528** serve as reference locations for sensor **510** in detecting the movement and position of pressurization system **360** relative to the flexible membrane or bongo of the fluid ink supply **342**. The exact number and location of datums **528** may be varied depending upon the type of ink supply.

Mechanical power transmission input portion **504** comprises a helical gear immovably coupled to drive mechanism **508**. Input portion **504** is configured to intermesh with worm gear **424** of motor assembly **333** (shown in FIGS. **8** and **11**). In alternative embodiments, input portion **504** may comprise other forms of a gear or other conventionally known or future developed transmission components or component. For example, portion **504** may alternatively comprise a pinion gear in intermeshing engagement with a corresponding pinion or spur gear associated with motor assembly **333**.

Mechanical power transmission input portion **506** comprises a transmission component immovably coupled to drive mechanism **358** configured to interact with a corresponding mechanical power transmission output portion of an adjacent module **344**. In the particular embodiment illustrated in which modules **344** of ink supply station **340** are substantially identical to one another, input portion **506** is configured to mate with mechanical power transmission output portion **508**.

Mechanical power transmission output portion **508** (shown in FIGS. **10** and **10**A) comprises a structure configured to mate with a mechanical power transmission input portion of an adjacent module **344** so as to permit the transmission of mechanical power or torque between adjacent modules **340**. In the particular module illustrated, mechanical power transmission input portion **506** comprises a hexagonal shaft while mechanical power transmission input portion comprises a hexagonal bore. In alternative embodiments, input portion **506** and output portion **508** may alternatively comprise a bore and shaft, respectively. In lieu of input portion **508** receiving output portion **506**, output portion **506** and input portion **508** may alternatively extend side by side or end to end during inter-engagement and mating. For example, in one embodiment, input portion **506** and output portion **508** may alternatively comprise intermeshing teeth of adjacent gears. These and various other mating or otherwise inter-engaging arrangements so as to transmit torque are contemplated.

Drive mechanism **358** comprises a cam immovably coupled to input portions **504** and **506**. Drive mechanism **358** is rotatably supported by chassis **502** so as to interact and engage pressurization system **360**. In the particular embodiment illustrated, drive mechanism **358**, input portions **504**, **506** and output portion **508** are all integrally formed as part of a single unitary body. As a result, manufacturing costs of module **344** are reduced. In alternatively embodiments, input portions **504**, **506**, output portion **508** and drive mechanism **358** may be provided by separate components fixedly or immovably coupled to one another.

In the particular embodiment illustrated, each module **344** is provided with input portion **504** and output portion **508**. Because each module includes input portion **504** and output portion **508**, each module **344** is completely interchangeable with one another regardless of whether the particular module **344** is an end-most module of the series of modules forming ink supply station **340**. In alternative embodiments, an end most one of modules **344** and ink supply station **340** may omit output portion **508**. Alternatively, only the end most module **344** directly coupled to motor assembly **333** need include input portion **504**.

Pressurization system **360** is operably coupled between drive mechanism **358** and the flexible diaphragm **154** (shown in FIG. **3**) of ink supply **42**. Pressurization system **360** is slidably disposed within an interior cavity **540** formed in chassis **502**. As best shown by FIG. **12**, pressurization system **360** includes movable member **542**, base member **544** and compression spring **546**. Movable member **542** (also known as a lifter) includes hub **550**, extension **552**, flag **554** and projections **556**. Hub **550** includes a hollow interior configured to receive an upper end of spring **546**. Hub **550** is slidably received within base member **544**. Extension **552** extends from hub **550** and is configured to pass through opening **558** of chassis **502**. Extension **552** includes membrane engagement surface **560** which bears against a lower surface of flexible membrane **154** of an ink supply **42**. Flag **554** projects from extension **552** and is configured to cooperate with sensor **510** to facilitate the detection of movement of movable member **542**. Projections **556** projects outwardly from hub **550** and interacts with base member **544** to releasably secure movable member **542** to base member **544**.

Base member **544** (sometimes referred to as a plunger) cooperates with movable member **542** to capture spring **546** therebetween and also guides movement of movable member **542**. Base member **544** includes floor **562**, peripheral wall **564** and drive mechanism engagement surface **566**. Floor **562** and wall **564** form an interior bore **568** sized to slidably receive hub **550** and also configured to capture spring **546** between movable member **542** and base member **544**. Wall **564** further includes an elongate grooves **570**, peripheral slot **572** and peripheral notches **574**. Grooves **570** extend opposite one another and slidably receive projections **556**. Grooves **570** communicate with peripheral slot **572**. Peripheral slot **572** extends along the periphery of wall **564** and communicates with notches **574**. Notches **574** generally extends along the central axis of extension **552** and are sized to slidably receive projections **556**.

Pressurization system **360** is assembled by moving projections **556** through grooves **570** until projections **556** are across from peripheral slot **572**. Movable member **542** is then rotated approximately 90 degrees within slot **572** until projections **556** are within notches **574**. As a result, spring **546** is captured between movable member **542** and base member **544**. Movable member **542** moves along axis **576** (shown in FIG. **12**) while notches **574** engage projections **556** to guide movement of movable member **542**. The resulting assembly forms a spring-loaded plunger.

Engagement surface **566** generally extends along a lower surface of floor **562** and is configured to engage drive mechanism **358**. Rotation of drive mechanism **358** moves base member **544** along axis **576** to compress spring **546** against movable member **542**. As a result, movable member **542** moves along axis **576** while in engagement with diaphragm **154** of ink supply **42**.

Overall, pressurization system **360** provides module **344** with a compact, low-cost, easily assembled mechanical assembly which reciprocates while in engagement with diaphragm **154** of ink supply **42** to pressurize fluid ink. In contrast to prior systems employing a rocker arm and a torsion spring connected to the rocker arm and to a chassis, pressurization system **360** provides extremely low stresses and minimizes the number of parts that are loaded by the spring. The resulting lower part stresses reduces part creepage or breakage. By minimizing the number of loaded parts in both pressurized and de-pressurized positions, pressurization system **360** improves reliability.

Sensor **510** is directly coupled to chassis **502** and is configured to detect or sense the movement or position of movable member **542** relative to the floor of ink supply **42** or its flexible membrane **154**. Sensor **510** is located relative to chassis **502** by sensor locator surfaces **580** (shown in FIG. **14**). Sensor locator surfaces **580** are precisely positioned to locate sensor **510** relative to ink supply locator surfaces **528**. In the particular embodiment illustrated, chassis **502** which provides both locator surfaces **528** and **580** is integrally formed as part of a single unitary body. As a result, the extent of potential dimensional variations of components between sensor **510** and ink supply locating surfaces or datums **528** (also known as tolerance stack) is reduced. In the particular embodiment illustrated, sensor locator surface **580** and ink supply locator surfaces **528** are formed from a common side of a common mold such that the part line of the mold extends to one side of both surfaces **580** and **528**. As a result, dimensional variation resulting in varying distances between sensor **510** and ink supply locator surfaces **528** during molding is further reduced. By reducing such dimensional variations or the tolerance stack, a more accurate detection of the movement and position of movable member **542** relative to ink supply locator surfaces **528** and the floor or membrane **154** of ink supply **42** is achieved. Such accurate sensing of the position of movable member **542** is achieved without requiring individual adjustment of sensor **510** or of pressurization system **360**.

As best shown by FIGS. **9** and **10**A, sensor **510** generally includes body **584**, sensing mechanism **586** and prongs **588**. Body **584** comprises a housing about sensing mechanism **586**. Sensing mechanism **586** senses movement of movable member **542**. In the particular embodiment illustrated, sensing mechanism **586** comprises a photo or optical detector generally including a light emitter **590**, a light receiver or detector **592** (schematically shown) and printed circuit assembly **594**. Light emitter **590**, light receiver **592** and printed circuit assembly **594** are conventionally known. Light emitter **590** and light receiver **592** are spaced from one another on opposite sides of an opening **596** formed within housing **584**. Opening **596** receives flag **554** of movable member **542**. Flag **554** interrupts the light passing from emitter **590** to receiver **592**. As a result, detector mechanism **586** senses movement of movable member **542** and its position in a conventionally known manner. A wiring harness (not shown) is connected to each of printed circuit assemblies **594** of sensors **510** and is further connected to controller **32** (shown in FIG. **1**).

Prongs **588** extend from body **584** and terminate at hooks **596**. As best shown by FIG. **14**, prongs **588** pass through corresponding slots within chassis **502**. During connection of sensor **510** to chassis **502**, prongs **588** resiliently flex towards one another to enable hooks **596** to pass below sensor locator surfaces **580**. Due to their tapered nature, prongs **588** engage chassis **502** to urge hooks **596** upwardly against sensor locator surfaces **580**. As a result, prongs **588** and hooks **596** ensure proper and consistent positioning of sensor **510** relative to chassis **502** which serves as a mounting structure for sensor **510**. The consistent positioning of sensor **510** relative to chassis **502** without requiring adjustment reduces assembly cost and facilitates more reliable and accurate position sensing of movable member **542**.

FIGS. **15** and **16** illustrate the interconnection of multiple modules **344**. As best shown by FIG. **15**, modules **344** are positioned relative to one another by aligning locators **520** with locators **522** and by aligning locators **524** with opposite locators **526**. Interconnection of modules **344** also results in input portions **506** mating with opposite output portions **508** to form a continuous transmission or drive train through modules **344** for rotating each of drive mechanisms **358** to move each of movable members **542**. In particular, as best shown by FIG. **16**, motor **420** which is mounted within mounting aperture **600** of one of modules **340** rotatably drives an output shaft **602** which in turn drives toothed belt **422** in engagement with gear **423** which is immovably coupled to worm gear **424** (shown in FIG. **11**). Worm **424** rotatably drives input portion **504** which is immovably coupled to output portion **508** (shown in FIG. **15**) and drive mechanism **358**. Drive mechanism **358** is rotated so as to move pressurization system **360** and movable member **542** against the flexible membrane **154** of ink supply **42** (shown in FIG. **3**).

At the same time, torque is transmitted from output portion **508** to an adjacent input portion **506** of an adjacent module **340**. As a result, any of a number of modules **340** may be releasably interconnected to one another while being driven by a single motor assembly **333**. Consequently, the same basic design of ink supply station **340** may be used in printers having different numbers of ink supplies. By enabling the use of the same basic design by printers having differing numbers of ink supplies, the amount of new tooling, design resources, qualification resources and time-to-market necessary to introduce a new printer is reduced. The sharing of ink supply station parts across different printers also reduces common part prices due to economies of scale. With little design effort, the acumen connector assembly **337**, support frame **331** and the photo interrupter wiring harness may be easily modified or stretched to accommodate differing numbers of modules **344**.

Although the present invention has been described with reference to example embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention. For example, although different example embodiments may have been described as including one or more features providing one or more benefits, it is contemplated that the described features may be interchanged with one another or alternatively be combined with one another in the described example embodiments or in other alternative embodiments. Because the technology of the present invention is relatively complex, not all changes in the technology are foreseeable. The present invention described with reference to the example embodiments and set forth in the following claims is manifestly intended to be as broad as possible. For example, unless specifically otherwise noted, the claims reciting a single particular element also encompass a plurality of such particular elements. Furthermore, those dependent claims that do not have limitations phrased in the "means or step for performing a specified function" format permitted by 35 U.S.C. §112, ¶6 are not to be interpreted under §112, ¶6 as being limited solely to the structure, material or acts described in the present application and their equivalents.

What is claimed is:

1. An ink supply station module for use with an ink supply and a first power transmission output portion, the module comprising:

- a chassis;
- a movable member supported by the chassis, wherein movement of the member causes flow of ink from the ink supply;
- a drive mechanism coupled to the movable member and configured to move the member; and
- a first power transmission input portion supported by the chassis and coupled to the drive mechanism, wherein the input portion is configured to be removably coupled to the first power transmission output portion, wherein the first power transmission input portion is configured to be removably coupled to the first power transmission output portion of another ink supply station module.

2. The module of claim **1**, wherein the drive mechanism includes a cam.

3. The module of claim **1** including a second power transmission input portion.

4. The module of claim **3**, wherein the second power transmission input portion is configured to be removably coupled to a second power transmission output portion.

5. The module of claim **3**, wherein the second power transmission input portion is to be coupled to a motor.

6. The module of claim **1** further comprising a second power transmission input portion, wherein the first power transmission input portion is configured to be releasably coupled to the first power transmission output portion of another ink supply station module and wherein the second power transmission input portion is configured to be coupled to a power transmission output portion of a motor.

7. The module of claim **1** including at least one first locating structure coupled to the chassis and configured to locate the module relative to another module.

8. The module of claim **7**, wherein the other module includes one of a receptacle and a projection configured to mate within the receptacle and wherein the locating structure includes the other of the receptacle and the projection.

9. The module of claim **1** including a sensor configured to sense movement of the movable member.

10. The module of claim **9**, wherein the sensor is coupled to and carried by the chassis.

11. The module of claim **9**, wherein the sensor is resiliently biased towards a predetermined position relative to the chassis.

12. The module of claim **9**, wherein the sensor includes:

a body;

a sensing mechanism coupled to the body;

a first prong extending from the body and terminating at a first hook, the first prong configured to slidably engage the chassis; and

a second prong extending from the body and terminating at a second hook, the second prong configured to slidably engage the chassis, wherein at least one of the first prong and the second prong is resiliently flexible so as to resiliently bias the first hook and the second hook against the chassis.

13. The module of claim **12**, wherein the sensing mechanism includes:

a light receiver; and

a light emitter spaced from the receiver and configured to direct light at the emitter.

14. The module of claim **1**, wherein the chassis includes:

at least one sensor locator surface configured to engage and locate the sensor; and

at least one ink supply locator surface configured to engage and locate the ink supply, wherein the at least one sensor locator surface and the at least one ink supply locator surface are integrally formed as part of a single unitary body.

15. The module of claim **1**, wherein the first power transmission input portion includes one of a fluid or pneumatic coupling.

16. The module of claim **1**, wherein the first power transmission input portion includes an electrical coupling.

17. The module of claim **16**, wherein the drive mechanism includes a solenoid.

18. The module of claim **1** further including a second power transmission output portion and the second power transmission input portion, wherein the first power transmission input portion, the second power transmission input portion, the second power transmission output portion and the drive mechanism are immovably coupled to one another as a single unit.

19. The station of claim **18**, wherein the first module includes a first pneumatic coupling and wherein the second module includes a second pneumatic coupling releasably connected to the first pneumatic coupling.

20. The module of claim **1** further comprising a second power transmission input portion.

21. The module of claim **1**, wherein the chassis, the movable member, the drive mechanism and the input portion are supported and carried by the chassis so as to be movable as a single unit independent of any other ink supply station modules of the ink supply station.

22. An ink supply station module for use with an ink supply and a first power transmission output portion, the module comprising:

a chassis;

a movable member supported by the chassis, wherein movement of the member causes flow of ink from the ink supply;

a drive mechanism coupled to the movable member and configured to move the member;

a first power transmission input portion supported by the chassis and coupled to the drive mechanism, wherein the input portion is configured to be removably coupled to the first power transmission output portion;

a base member; and

a spring operably coupled between the base member and the movable member, wherein the drive mechanism applies force to the base member to move the movable member.

23. The module of claim **22**, wherein the spring is captured between the base member and the movable member.

24. The module of claim **22**, wherein the movable member is slidably coupled to the base member.

25. The module of claim **22**, wherein the base member and the movable member move along a common axis.

26. The module of claim **22**, wherein the first power transmission input portion includes a mechanical coupling configured to transmit torque.

27. The module of claim **26**, wherein the first input portion includes a gear.

28. The module of claim **26**, wherein the first input portion is configured to be keyed to the first output portion.

29. The module of claim **22**, wherein the base member is coupled between the movable member and the drive mechanism.

30. An ink supply station for use with a first ink supply and a second ink supply, the station comprising:

a first module including:

a first chassis; and

a first movable member supported by the chassis, wherein movement of the member causes flow of ink from the first ink supply; and

a second module releasably coupled to the first module, the second module including:

a second chassis;

a second movable member supported by the second chassis, wherein movement of the second member causes flow of ink from the second ink supply;

a first drive mechanism coupled to the first movable member and configured to move the first movable member and wherein the second module includes a second drive mechanism coupled to the second movable member and configured to move the second movable member; and

a first mechanical power transmission input portion coupled to the first drive mechanism and wherein the second module includes a first mechanical power transmission output portion releasably connected to the first mechanical power transmission input portion.

31. The station of claim **30**, wherein the first module includes a first locator structure and wherein the second module includes a second locator structure configured to mate with the first locator structure to locate the first module relative to the second module.

32. The station of claim **31**, wherein the first locator structure includes one of a receptacle and a projection received within the receptacle and wherein the second locator structure includes the other of the receptacle and the projection.

33. The station of claim **30**, wherein the second module includes a second mechanical power transmission input portion.

34. The station of claim **30** including a motor having an output shaft coupled to the second mechanical power transmission input portion.

35. The station of claim **34**, wherein the output shaft is releasably coupled to the second mechanical power transmission input portion.

36. The station of claim **35**, wherein the base member and the first movable member move along a common axis.

37. The station of claim **30**, wherein the first module and the second module are identical to one another.

38. The station of claim **30**, wherein the first module includes a first sensor coupled to and supported by the first chassis and configured to sense movement of the first movable member and wherein the second module includes a second sensor coupled to and supported by the second chassis and configured to sense movement of the second movable member.

39. The station of claim **38**, wherein the first movable member is slidably coupled to the base member.

40. The station of claim **30**, wherein the first module includes a first sensor resiliently biased towards a predetermined position relative to the first chassis.

41. The station of claim **30**, wherein the chassis includes:

at least one sensor locator surface configured to engage and locate a sensor; and

at least one ink supply locator surface configured to engage and locate an ink supply, wherein the at least one sensor locator surface and the at least one ink supply locator surface are integrally formed as part of a single unitary body, wherein the movable member is movable relative to the ink supply locator surface and the at least one sensor locator surface.

42. The station of claim **41**, wherein the at least one sensor locator surface and the at least one floor locator surface are formed from a common side of a common mold.

43. The station of claim **30** including a frame releasably coupled to the first module and the second module.

44. The station of claim **30**, wherein the first module includes a drive mechanism, wherein the drive mechanism applies force to the base member to move the first movable member.

45. The station of claim **30**, wherein the spring is captured between the base member and the movable member.

46. The station of claim **30**, wherein the first module includes a first electrical coupling and wherein the second module contains a second electrical coupling releasably connected to the first coupling.

47. The station of claim **30**, wherein the first module includes a first hydraulic coupling and wherein the second module includes a second hydraulic coupling releasably connected to the first hydraulic coupling.

48. The station of claim **30** further comprising:

a base member;

a spring operably coupled between the base member and the movable member.

49. The station of claim **48**, wherein the base member is coupled between the movable member and the drive mechanism.

50. The station of claim **30**, wherein the second module is configured to be removed from the ink supply station and wherein the first module is configured to deliver fluid from the first ink supply while the second module is removed from the ink supply station.

51. An ink supply station for use with a fluid path from an ink reservoir to a printhead and a flexible membrane situated along the fluid path, the station comprising:

a chassis integrally formed as part of a single unitary body;

a movable member movably supported by the chassis and configured to engage the flexible membrane to pressurize ink along the fluid path; and

a sensor directly coupled to the chassis and configured to sense movement of the movable member;

wherein the sensor includes:

a body;

a sensing mechanism coupled to the body;

a first prong extending from the body and terminating at a first hook, the first prong slidably engaging the chassis; and

a second prong extending from the body and terminating at a second hook, the second prong slidably engaging the chassis, wherein at least one of the first prong and the second prong is resiliently flexible so as to resiliently bias the first hook and the second hook against the chassis.

52. The station of claim **51**, wherein the sensor is resiliently biased towards a predetermined position relative to the chassis.

53. The station of claim **51** including:

a frame; and

a module releasably coupled to the frame, wherein the module includes the chassis and the movable member.

54. The station of claim **51** including:

a first module; and

a second module releasably coupled to the first module, wherein the second module includes the chassis and the movable member.

55. The station of claim **51**, wherein the chassis includes at least one floor surface adapted to engage an ink supply to locate the ink supply relative to the movable member.

56. The station of claim **55**, wherein the chassis includes at least one sensor locator surface adapted to engage and locate the sensor relative to the chassis and wherein the at least one floor surface is integrally formed as part of a single unitary body with the at least one sensor locator surface.

57. The station of claim **56**, wherein the at least one sensor locator surface and the at least one floor surface are formed from a common side of a common mold.

58. The station of claim **51**, wherein the sensing mechanism includes:

a light receiver; and

a light emitter spaced from the receiver and configured to direct light at the emitter.

59. The station of claim **58**, wherein the movable member includes a flag and wherein the sensor senses a position of the flag between the receiver and the emitter.

60. An ink supply system comprising:

an ink reservoir;

a fluid passage extending from the reservoir;

a flexible membrane adjacent the fluid passage; and

a pressurization system including:

a movable member;

a base member; and

a spring coupled between the base member and the movable member; and a drive mechanism configured to apply force to the base member to move the movable member so as to move the membrane.

61. The system of claim **60**, wherein the drive mechanism includes a cam.

62. The system of claim **60** including an ink supply, wherein the ink supply includes the ink reservoir, the fluid passage and the flexible membrane.

63. The system of claim **62** including a module having a chassis coupled to and supporting the movable member, the base member, the spring and the drive mechanism.

64. The system of claim **63**, wherein the module includes a mechanical power transmission output portion configured to be releasably coupled to a mechanical power transmission input portion of another module.

65. The system of claim **60**, wherein the base member is coupled between the movable member and the drive mechanism.

66. An ink supply station module for use with an ink supply and a first power transmission output portion, the module comprising:

a chassis;

a movable member supported by the chassis, wherein movement of the member causes flow of ink from the ink supply;

a drive mechanism coupled to the movable member and configured to move the member; and

a first power transmission input portion supported by the chassis and coupled to the drive mechanism, wherein the input portion is configured to be removably coupled to the first power transmission output portion; and

a second power transmission input portion, wherein the first power transmission input portion is configured to be releasably coupled to the first power transmission input portion of another ink supply station module and wherein the second power transmission input portion is configured to be coupled to a power transmission output portion of a motor.

67. An ink supply station for use with a first ink supply and a second ink supply, the station comprising:

a first module including:

a first chassis; and

a first movable member supported by the chassis, wherein movement of the member causes flow of ink from the first ink supply; and

a second module releasably coupled to the first module, the second module including:

a second chassis;

a second movable member supported by the second chassis, wherein movement of the second member causes flow of ink from the second ink supply;

a base member; and

a spring operably coupled between the base member and the movable member, wherein the first module includes a drive mechanism, wherein the drive mechanism applies force to the base member to move the first movable member.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,207,666 B2
APPLICATION NO. : 10/636925
DATED : April 24, 2007
INVENTOR(S) : Jason S. Ord et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In column 12, line 62, in Claim 5, after “is” insert -- configured --.

Signed and Sealed this

Sixteenth Day of September, 2008

JON W. DUDAS
Director of the United States Patent and Trademark Office